

HANDBOOK OF
MAMMALS OF KANSAS

by E. Raymond Hall



Museum of Natural History and
State Biological Survey
University of Kansas

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NATURAL HISTORY

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The HANDBOOK OF MAMMALS OF KANSAS results from a continuation of the work of the State Biological Survey of Kansas and is a response to a large number of requests for a booklet of this general nature.

Mammal in color on front of the cover is a Fox Squirrel

HANDBOOK OF MAMMALS OF KANSAS

By

E. Raymond Hall

Contribution from The State Biological Survey of Kansas

MUSEUM OF NATURAL HISTORY
UNIVERSITY OF KANSAS
LAWRENCE, KANSAS

UNIVERSITY OF KANSAS
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PURPOSE AND SCOPE

This handbook is designed to meet the needs of persons who have little or no technical knowledge of Biology, but who are interested, either casually or seriously for one reason or another, in the native mammals of Kansas. The term "native mammal" is here used to denote one that occurs in the State without having been brought there by man, or a kind that occurred in the State when White Man first came to North America although the animal may now be extinct in Kansas, as for example the Black Bear.

Also, accounts are included of three or four non-native species that have been introduced by man, and that have become established as a part of the free-living fauna. These species are the Black Rat, Norway Rat, House Mouse, and possibly the Red Fox; there is some doubt about the native *versus* non-native status of the Red Fox. Not included, however, are several kinds of non-native mammals that we ordinarily refer to as domesticated. For example, livestock of all kinds, dogs and cats are excluded. It is true that many cats have taken up a life in the wild state and it must, therefore, be admitted that there is some inconsistency in our having drawn the line where we have between the kinds of non-native mammals that are included in the Handbook and those that are excluded from it.

Extinct species that died out before the beginning of historic time likewise are not included; they are treated in another publication by Professor H. H. Lane (*Trans. Kansas Academy of Science*, Vol. 50: 130-163, 273-314, 1947, and Vol. 51: 29-76, 1948).

Other species of probable, but unverified, occurrence are listed on page 246. These are incorporated in the keys for the convenience of persons who may discover some of these mammals.

MATERIALS

The present account is based more on "Mammals of Kansas" by E. Lendell Cockrum than on any other one source. That important and basic contribution (*University of Kansas Publications, Museum of Natural History*, Vol. 7, No. 1, pp. 1-303, 73 figures in text, 37 tables, August 25, 1952) considered the factors affecting the distribution of each kind and provided a synonymy for each. This technical information had to be assembled before a general or semi-popular account such as follows could be prepared with any reasonable degree of accuracy. The demand for Cockrum's "Mammals of Kansas" was so great that the supply that was allocated for distribution to individuals soon was exhausted. This circumstance had most to do with the preparation of the present account and its publication at this time. Parts of the following account (for example 49 of the maps showing the geographic distribution of species in

Kansas) are taken directly from Cockrum's publication. Of course the collection of mammals in the Museum of Natural History at the University of Kansas at Lawrence has been drawn upon and in instances where specimens that extend the known geographic range of a given species have been collected since Cockrum wrote his manuscript, these marginal records of occurrence are shown on a newly made distribution map beyond and are mentioned in the corresponding text. The symbols for locality records on the distribution maps are explained on page 248. Accounts of habits and behavior are based on the observations of many different mammalogists; most of these workers made their observations and studies in areas outside Kansas.

CLASS MAMMALIA

How do mammals differ from other animals? If the person who asks that question likes to have his information classified, it is appropriate to answer about as follows: All things known to us may be thought of as non-living or living. The living things are divided into plants and animals. Characteristics of animals are that they move about and that they eat plants or other animals. So, there, in a general way, is a definition of an animal!

Animals, according to the structures of the different species, are divided into a number of major categories termed Phyla. For example, there is the Phylum Protozoa (one-celled animals), Phylum Porifera (sponges), and Phylum Chordata (chordates—animals having a notochord). The Phylum Chordata is made up of several Sub-phyla, one of which is the Sub-Phylum Vertebrata (vertebrates—animals having back-bones made up of vertebrae). The Sub-Phylum Vertebrata, in turn, is divisible into several Classes; there are, among others, Class Pisces (bony fishes), Class Aves (birds), and Class Mammalia (mammals). Mammals differ from other Classes of vertebrate animals in possessing hair and in having milk-secreting glands in the female. So, there is a definition of a mammal; mammals, therefore, are one group (a Class) of animals.

The Class Mammalia is divided into Orders, an Order into Families, a Family into Genera, a Genus into Species, and a Species into Subspecies. Accounts of the structures characterizing each of the categories above the level of species are to be found in general books on Mammals (for example, Field Book of North American Animals, by H. E. Anthony; G. Putnam & Sons, 1927) and textbooks on vertebrate zoology; therefore, such information is not repeated here. Names of Orders, Families, and some Genera, however, are given in correct position on the following pages that deal primarily with species. Directions for using the keys are given on page 251.

KEY TO ORDERS OF MAMMALS OF KANSAS

1. Inner (first) toe of hind foot without nail and opposable; ten upper incisor teeth Order Marsupialia (Opossum), page 10
- 1'. Inner (first) toe of hind foot absent, or if present with a nail and not opposable; upper incisor teeth absent or fewer than ten.

 2. Skin-covered bony plates forming hard shield on dorsum; incisors and canine absent in lower jaw; all teeth simple and peglike Order Edentata (Nine-banded Armadillo), page 58
 - 2'. No hard shield on dorsum; incisors, or incisors and canine, present in lower jaw; some or all teeth not simple and not peglike.

 3. Feet with hooves (not claws); incisor teeth absent in upper jaw see key to Order Artiodactyla, page 226
 - 3'. Feet with claws or nails (not hooves) although forefoot of bats has claw on only first digit; incisor teeth present in upper (and lower) jaw.

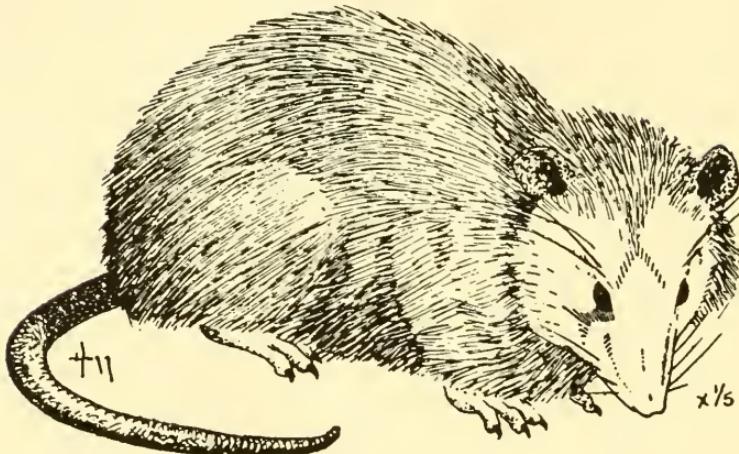
 4. Fingers lacking nails or claws (thumb has claw), and longer than forearm; fingers supporting a leathery membrane which serves as a wing see key to Order Chiroptera (bats), page 22
 - 4'. Fingers with nails or claws, and shorter than forearm; fingers not supporting a leathery membrane for flight.
 5. Skull without canine teeth; a true diastema present (see figs. 10-50).

 6. Ears shorter than tail-vertebrae; total of 2 upper incisor teeth see key to Order Rodentia, page 77
 - 6'. Ears longer than tail-vertebrae; total of 4 upper incisor teeth see key to Order Lagomorpha (rabbits and hares), page 60
 - 5'. Skull with canine teeth; no true diastema present (see figs. 2-4, 10, 51-68).

 7. Orbit surrounded by bone; walks on only hind feet; no external tail Order Primates (Man), page 54
 - 7'. Orbit without bony border posteriorly; walks on all four feet; well-developed external tail.

 8. In upper jaw first tooth larger than any one of succeeding four; 3 molars in upper jaw; tail so scantily haired as to reveal scaly annulations on tail see key to Order Insectivora (mole and shrews), page 14
 - 8'. In upper jaw 4th tooth larger than any one of preceding three; 1 or 2 molars in upper jaw; tail so densely haired as to conceal skin on tail see key to Order Carnivora, page 166

ORDER MARSUPIALIA
FAMILY DIDELPHIDAE
Genus *Didelphis* Linnaeus
Opossum
Didelphis marsupialis Linnaeus



The Opossum is commoner in the eastern than in the western part of the State. This species is nocturnal and prefers timbered or brushy areas. It lives mostly in burrows, dug by other mammals, in the ground or in hollows or crevices in rock ledges, in hollow trees, in hollow logs, or in tangles of dense vegetation. Some zoologists think there were no Opossums in western Kansas until settlers brought in trees and shrubs that provide some cover.

Although most Opossums are gray, some are black owing to the long guard hairs being black. Once I captured a reddish (cinnamon) Opossum two miles south of Le Loup, Kansas, and once I saw a white one from somewhere in eastern Kansas.

The Opossum is omnivorous. A careful analysis of the contents of the digestive tracts of 60 Opossums trapped in Douglas County of eastern Kansas by Lewis L. Sandidge in winter, September 25 to March 17, disclosed that, by bulk, the food was as follows: insects, 42%; mammals, 41%; birds, 3%; fruit, 9%. The remaining 5% was made up of lizards, a snake, a frog, centipedes, a crayfish, snails and seeds of plants. Some of the bird- and mammal-items were carrion. Contrary to popular belief, Opossums rarely molest poultry.

"Playing 'possum", that is to say feigning death, may be resorted to if the Opossum is attacked by, say, a dog, or if roughly handled when first captured. An individual that I once had, "saved its skin" in this way. After my dog and I, at the edge of a dried-up pond, had unearthed the Opossum from a shallow burrow made and deserted by a Muskrat I was carrying the Opossum home alive. Pausing at the last one of a line of steel traps set for furbearers, I laid the animal down to reset the trap. Knowing that the Opossum was only slightly, if at all, injured, I was amused at the realistic manner in which it feigned death. Glancing at it occasionally to see that it was not escaping, I finally concentrated too long on resetting the trap for when I again looked at the place where the Opossum had been it was gone. My dog came at my call and followed the trail a few feet into some tall slough grass to the mouth of a deep burrow into which the Opossum probably had gone. I have watched other Opossums that were feigning death. When I remained perfectly still an Opossum would very slowly open his eyes, slowly get to his feet, then take a few stealthy steps and finally scurry at top speed for a safety retreat. The top speed is slow compared with that of a person and I was always able to overtake such an animal—except in the first instance mentioned above. Some of the Opossums thus recaptured as I remember them, quickly feigned death again but most of them attempted, instead, to bite and struggled to escape. When any Opossum was feigning death, however, a quick movement on my part when he was opening his eyes or just beginning to get to his feet usually would cause him to play dead again. In a burrow or in a hollow in a tree I have never seen one "play possum", even after I had knocked him about in an effort to secure a hold that would protect me from his sharp teeth. Under these circumstances an Opossum usually defends himself with his teeth and I have three times had the tip of a finger bitten all the way through. In none of these instances did any infection develop, so far as I can recall.

At night a person and dog can easily capture Opossums because they are so deliberate that only a small percentage can scramble up trees before being overtaken. They are attracted to meat-baits and are easily trapped. In 1928, when fur prices were high, 350,286 Opossum pelts were sold from Kansas. Although the price per individual pelt is low, so many are caught that the total return is high. Opossum, roasted with sweet potatoes, makes a tasty dish.

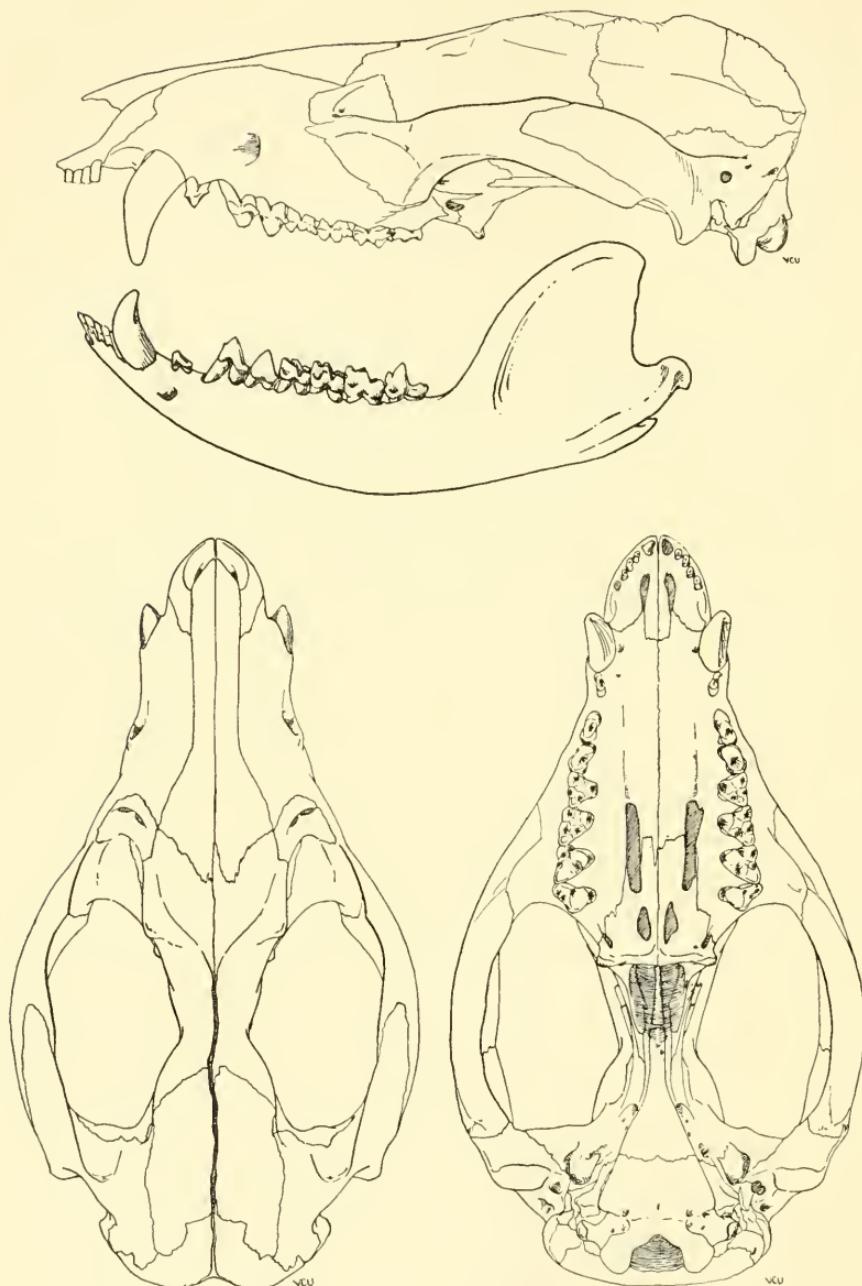
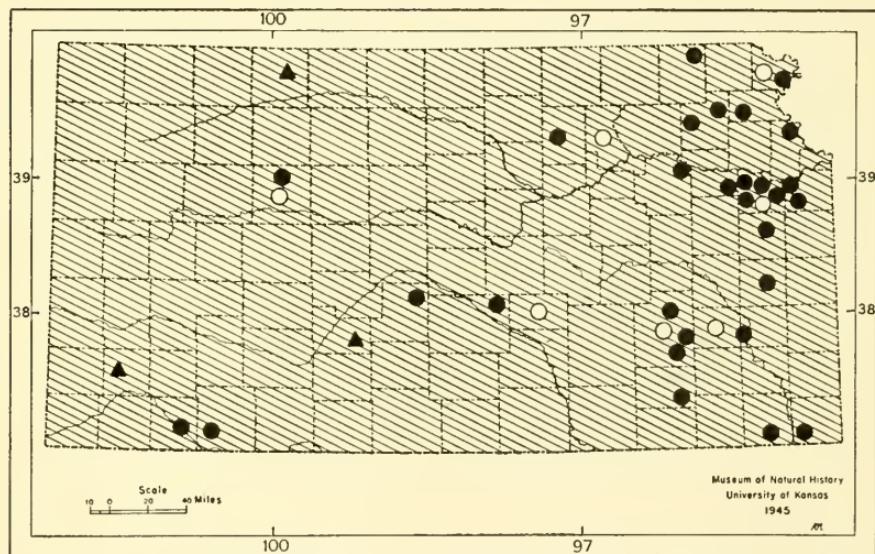


FIG. 1. Three views of skull of Opossum, *Didelphis marsupialis virginiana* Kerr, 1 mi. N Lawrence, Douglas Co., Kansas, ♂, No. 3780KU, $\times \frac{3}{4}$.

Opossums have large litters; one litter of 21 is reported! However, the teats of the female vary from 11 to 17 and any young born in excess of the number of teats are doomed to starve to death.

The Opossum belongs to the Order Marsupialia, the order of pouched mammals. When born, the young of this Order are exceptionally immature. For example, a young Opossum at birth weighs only approximately 1/10,000th as much as the mother instead of 1/18th as in some higher mammals. After a gestation period of approximately 11 days the young are born and crawl into the pouch on the lower abdomen; there each attaches itself to a teat which it does not release for approximately 70 days. At the end of this time the condition of the young roughly corresponds to the condition of other kinds of young mammals at birth.



The range is state-wide.

Description.—Total length, 700; tail, 300; hind foot, 50-75; ear from notch, 50; weight, up to 12 lbs. Grayish (guard hairs white, underfur black-tipped); underparts white; feet and lower legs black; toes more or less white. Ears naked, black with white tips; tail nearly naked and prehensile; toes five; first toe on hind foot large, clawless and opposable to the others in grasping. Teeth, 50; 10 are upper incisors and 8 are lower incisors. No other mammal in Kansas has so many as 18 incisors.

Only one subspecies, *Didelphis marsupialis virginianus*, occurs in Kansas. It was named by Kerr (The Animal Kingdom, p. 193, 1792) and the type locality is in "Virginia." Other subspecies occur farther south.

ORDER INSECTIVORA

KEY TO INSECTIVORA (MOLE AND SHREWS)

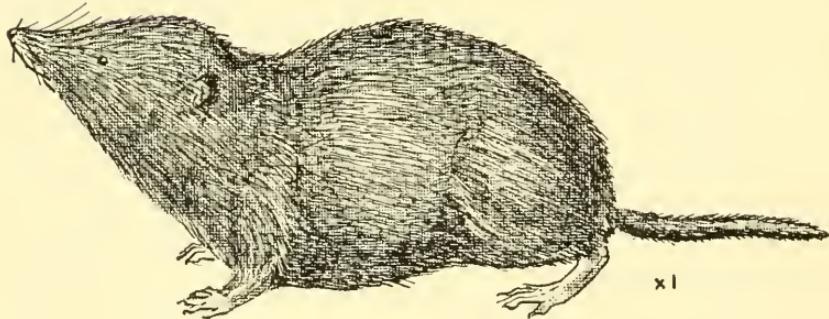
1. Total length more than 150 mm.; forelegs modified for digging; skull more than 30 mm. long Eastern Mole, page 19
- 1'. Total length less than 150 mm.; forelegs not modified for digging; skull less than 30 mm. long.
 2. Teeth, 28 Desert Shrew (not recorded from Kansas), page 246
 - 2'. More than 28 teeth.
 3. Total length more than 100 mm.; hind foot more than 11 mm.; 32 teeth Short-tailed Shrew, page 14
 - 3'. Total length less than 100 mm.; hind foot less than 11 mm.; 30 teeth Little Short-tailed Shrew, page 17

FAMILY SORICIDAE

Genus *Blarina* Gray

Short-tailed Shrew

Blarina brevicauda (Say)



The Short-tailed Shrew lives on the ground and in shallow burrows, more often in wooded or brushy areas than in grasslands. It makes runways through the ground litter and is active at certain hours of the day as well as at night. Insects make up half of its food in summer and three-fifths of its food in winter. Locally, *Blarina* may act as an actual control on certain insects. For exam-

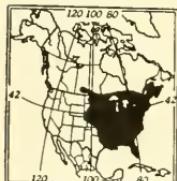
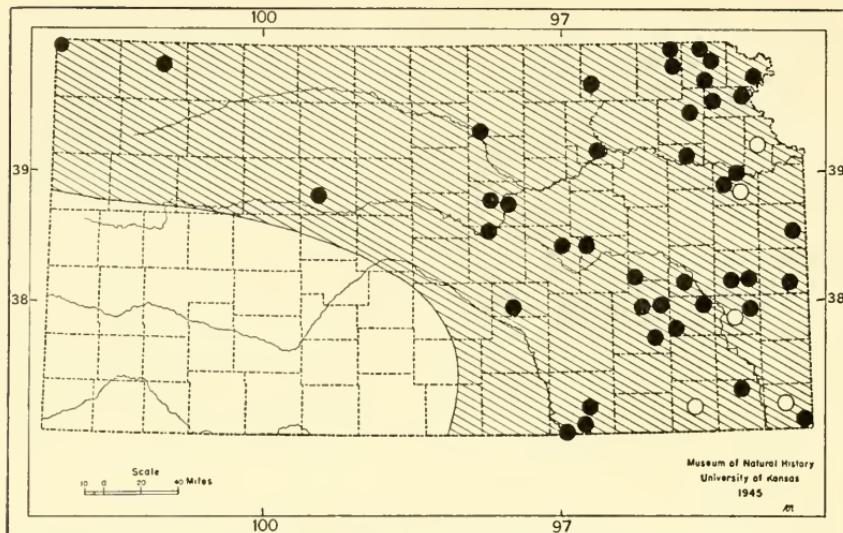
ple, 40 per cent of the cocoons of the larch sawfly in New Brunswick are consumed by this shrew, and in West Virginia it eats most of the chestnut worms in some small areas. In winter, in some places, it kills and eats meadow mice that are larger than the shrews. Snails are a favorite food in winter in some areas and are stored in underground chambers as also are some other foods. Snails sometimes are brought out and piled on top of the snow near the mouth of a burrow of the shrew. Its saliva is poisonous and is used in subduing animals that the shrew kills for food. The poison is secreted in the lower jaw, in the submaxillary salivary gland. Enough poison can be extracted from this gland to kill, by injecting it into the blood stream, 200 white mice or several cats or rabbits. There is no instance on record, however, of a person being poisoned by any shrew.

The Short-tailed Shrew is preyed upon by owls and hawks. Many of these shrews are killed also by carnivorous mammals but the carnivores do not always eat the shrews. Red Foxes, for example, are known to leave numbers of the shrews uneaten at the entrances of the dens of the foxes. I am not sure that any carnivore eats shrews. Domestic cats, it will be recalled, catch and kill shrews. The considerable number of shrews that cats carry to the back steps and leave there is evidence in support of the above statement.

Nests made of leaves and plant materials are constructed under logs or in shallow burrows. Nests for resting are smaller than those in which the young are reared. One female can produce three or more litters per season. The gestation period is 21 to 22 days. Five, six and seven are common numbers of young in a litter but as few as three and as many as ten have been recorded.

Many persons confuse *Blarina* with native species of mice. Actually shrews are not closely related to mice. From man's point of view the Short-tailed Shrew is beneficial in that much of its food is insects; some of these insects are pests to agriculturists.

Jones and Findley (Trans. Kansas Acad. Sci., 57:208, August 2, 1954) have reviewed the classification and distribution in Kansas of *Blarina brevicauda*. The account above reflects the findings of these two students.



The Short-tailed Shrew has not been reported from that part of Kansas southwest of a line connecting the following localities: 15 mi. N and 11½ mi. W St. Francis (Cheyenne Co.); 3½ mi. W and ¾ mi. S Hays, 2150 ft. (Ellis Co.); 1 mi. E and ½ mi. N Halstead (Harvey Co.); 3 mi. SE Arkansas City (Cowley Co.).

Description.—Total length, 92-120; tail, 20-24; hind foot, 13-18. Sooty plumbeous, slightly paler below than above; snout long and pointed; 32 teeth.

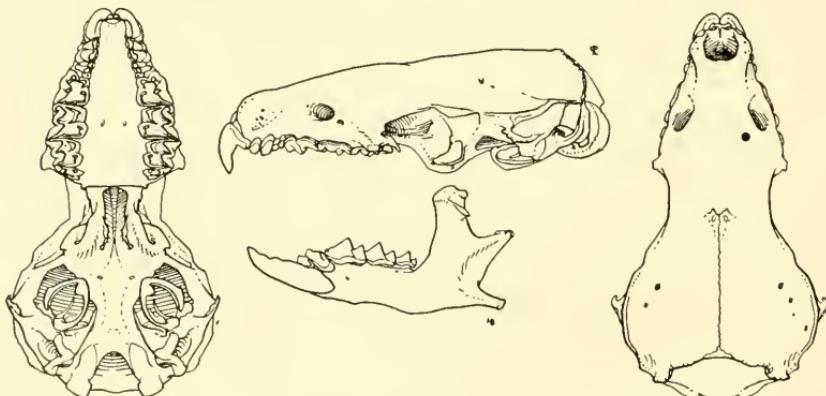


FIG. 2. Three views of skull of Short-tailed Shrew, *Blarina brevicauda* [subspecies, *kirtlandi* Bole and Moulthrop], 1 mi. W Highland Park, Lake Co., Illinois, ♀, No. 81749MVZ, $\times \frac{1}{2}$.

In Kansas there is only one subspecies, *Blarina brevicauda carolinensis*, named by Bachman (Jour. Acad. Nat. Sci. Philadelphia, 7(part 2):366, 1837), with type locality as eastern South Carolina.

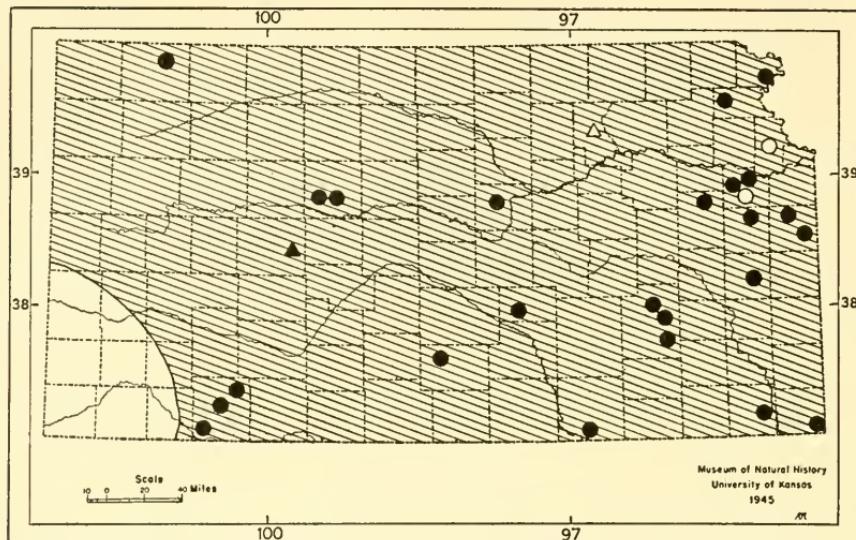
Genus *Cryptotis* Pomel
Little Short-tailed Shrew
Cryptotis parva (Say)



The Little Short-tailed Shrew uses the runways and burrows of mice and makes burrows of its own in leafmold and the topsoil. In the stomachs of these small shrews, one investigator found remains of insects, earthworms, centipedes, mollusks, and plants. Nests of this species have been reported from beehives in Indiana where the shrew was thought to feed upon the brood. Except in an instance of this kind the Little Short-tailed Shrew is judged to be beneficial; it eats principally insects some of which levy on Man's crops. Several naturalists have weighed the amounts of food consumed by captives of this species and ascertained that a shrew will eat more than his own weight every 24 hours for many days in succession. It may be, however, that in the wild state, where a variety of natural foods is available, this shrew ordinarily consumes no more than 60 per cent of its weight in 24 hours. Even this amount is relatively large, but it is in keeping with the rapid rate of digestion. Materials appear in the excreta in anywhere from one hour and thirty-five minutes to four hours after being eaten.

Four, five and six are the usual numbers of young although as few as two and as many as eight have been recorded. Probably each female has more than one litter in a season; embryos have been found as early as April and as late as October. At birth a young of this species weighs (.32 grams) approximately one-twelfth as much as the mother (4 grams).

The shrews, along with all of the other placental mammals, have young that are in a much more advanced stage of development than are the young of the Marsupialia, the order of pouched mammals to which the Opossum belongs. Among all of the placental (four separate parts to the membrane surrounding the embryo) mammals, however, none that occurs in Kansas is more primitive than the shrews. They differ less than might be expected from some of the earliest fossil remains of primitive mammals.



The distribution of this shrew probably is state-wide but its presence is yet to be verified in the southwestern counties. The southwesternmost record station of occurrence is 17 mi. W Meade.

Description.—Total length, 71-81; tail, 16-18; hind foot, 11. Dark brown above and ashy below. Snout long and pointed; 30 teeth (one less incisor on each side of the upper jaw than in *Blarina*). This is the smallest mammal in the State; fully grown individuals weigh as little as one-seventh of an ounce.



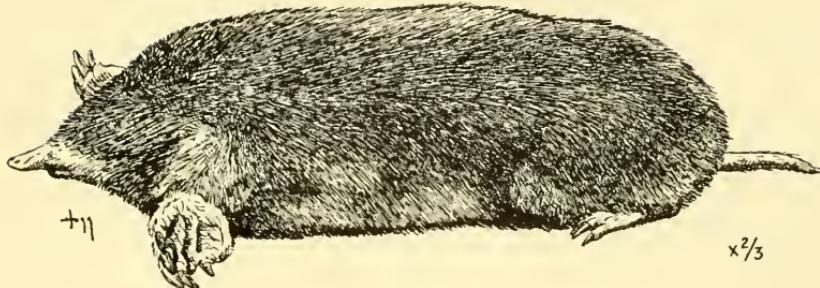
FIG. 3. Three views of skull of Little Short-tailed Shrew, *Cryptotis parva parva* (Say), Monroe, Ouachita Co., Louisiana, ♀, No. 70505MVZ, $\times 2$.

Cryptotis parva parva, the only subspecies that occurs in Kansas, was named by Say (Long's Expedition to the Rocky Mountains, 1:163, 1823) with type locality on the west bank of the Missouri River near Blair, Engineer Cantonment, Washington County, Nebraska. Hamilton (1944:1-7) has written of the habits of this species and cites other writings that should be consulted by anyone undertaking to investigate the life-history of the Little Short-tailed Shrew.

FAMILY TALPIDAE

Genus *Scalopus* Geoffroy

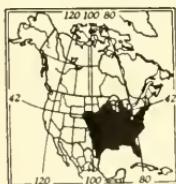
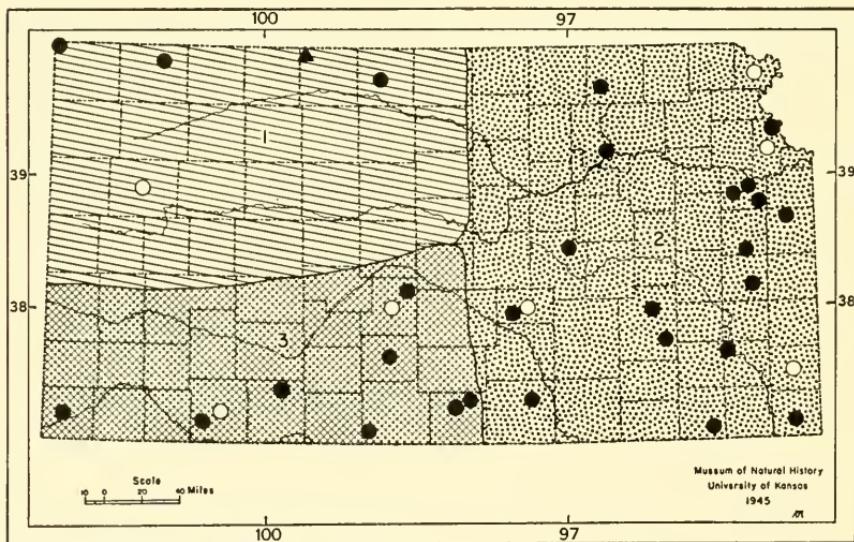
Eastern Mole

Scalopus aquaticus (Linnaeus)

Moist rich soils are preferred. Consequently, in western Kansas, moles are found mainly along streams. These animals are both nocturnal and diurnal. More than 99 per cent of a mole's life is spent below ground in tunnels of its own construction. These tunnels are of two sorts. One is made only an inch or two below the surface of the ground by the mole "swimming" through the loose topsoil. In constructing this kind of runway the mole leaves a ridge of earth on the surface of the ground. More permanent tunnels are made six to ten inches below the surface of the ground and no telltale ridge of earth is left on the surface, but, instead, mounds of earth are thrown up at intervals. These are likely to be confused with those made by pocket gophers. Knowledge of how the mounds of each are constructed permits a person to distinguish one from the other. From the main tunnel of the mole a short shaft extends straight up to the surface. The soil that is expelled from this vertical shaft wells up like water and successive loads form a nearly circular mound on which there may be "ripple marks" in the form of complete circles. In contrast, from the main tunnel of the pocket gopher there is a short inclined tunnel to the surface. Through this tunnel successive loads of soil are pushed out in one direction, each partly on top of the one before, thus forming a mound on which half circles are visible.

Animal matter makes up nearly all of the food of the mole. It eats more earthworms than anything else; grubs, other soft-bodied

insects, and even hard-shelled insects also are eaten. Most of this food is obtained while the mole is making its shallow burrows described above. Sometimes planted seeds or tuberous plants, for example potatoes, along the route of these shallow tunnels are partly eaten. Formerly it was thought that this vegetable material was eaten only by mice which invaded the mole runs and by the grubs which the mole sought and ate. Later studies indicate that this is true in more than nine-tenths of the instances investigated but there also is evidence that the moles themselves sometimes eat small amounts of the vegetable material concerned. From the point of view of the owner of the crop the mole is at least indirectly responsible even though his food habits are mostly beneficial since large numbers of grubs are eaten. Special traps of the stabbing variety, set by skilled hands, are the best means of eliminating moles from places where they are a nuisance.



Distribution of *Scalopus aquaticus*.

1. *S. a. caryi*. 2. *S. a. macrinooides*. 3. *S. a. intermedius*.

Description.—Total length, 132-187; tail, 23-37; hind foot, 19-27; weight, 3 to 4 ounces. Pelage lead-colored tinged with brown, often with a tinge of either silvery gray or purplish; fur velvety; forefeet broad and flat; snout long, pointed and scantily haired; no external ear conchs; no eye-openings. By the two features last mentioned, moles can be distinguished from their smaller relatives, the shrews. There are 36 teeth (38 in immature individuals), which number is greater than in the mole's relatives, the shrews.

The nest, constructed underground of fine grasses or leaves, is in a chamber four to six inches in diameter. The two that I found were in slightly raised areas. Water drained away from the nest when heavy rains soaked the ground. The nests were dug into while I was vigorously excavating for foundations for grain bins and in each instance some of the burrows were ruined before I had opportunity to study them. There were more than two burrows connected to each nest but I was unable to find any burrow encircling a nest, as has been described. Four young is the usual number and it seems that there is only one litter per year.

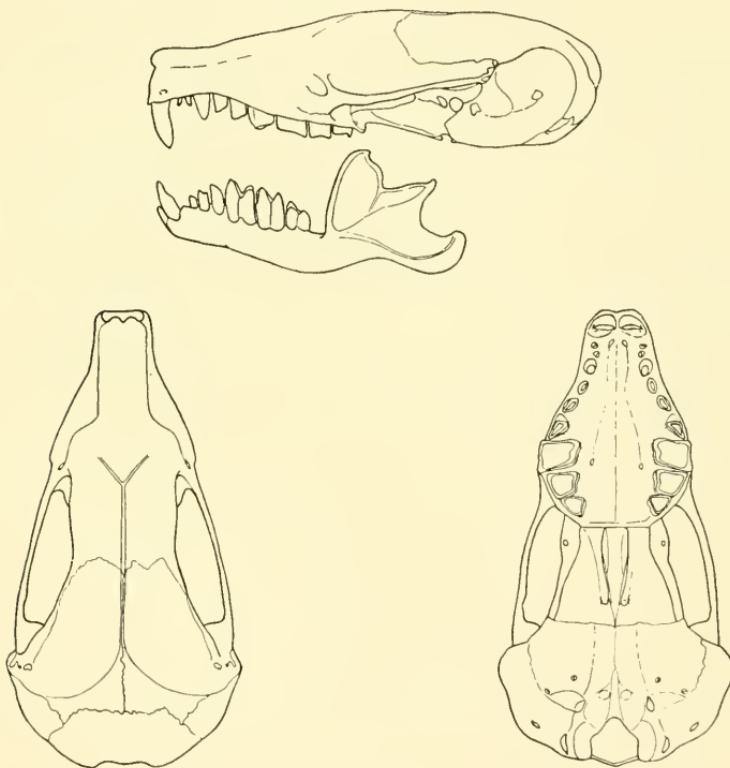


FIG. 4. Three views of skull of Eastern Mole, *Scalopus aquaticus macrinoides* Jackson, Hamilton, Greenwood Co., Kansas, ♂, No. 95767MVZ, $\times 2$.

There are three subspecies in Kansas. *Scalopus aquaticus caryi* was named by Jackson (Proc. Biol. Soc. Washington, 27:20, 1914) with type locality at Neligh, Antelope County, Nebraska. *S. a. macrinoides* was named by Jackson (Proc. Biol. Soc. Washington, 27:19, 1914) with type locality at Manhattan, Riley County, Kansas. *S. a. intermedius* was named by Elliot (Field Columbian Mus., publ. 37, zool. ser., 1:280, 1899) with type locality at Alva, Woods County, Oklahoma.

ORDER CHIROPTERA

KEY TO BATS

- | | |
|--|--|
| 1. Tail not extending more than 3 mm. behind uropatagium; anterior border of ear without horny excrescences; anterior border of palate truncate or rounded. | |
| 2. Ear from notch less than 20. | |
| 3. Two upper incisors on each side. | |
| 4. Dorsal surface of interfemoral membrane entirely bare or furred only slightly at extreme base; 38 or 32 teeth. | |
| 5. Tip of tail not extending beyond interfemoral membrane; total length less than 105; 38 teeth. | |
| 6. Length of foot 48 to 60 per cent of length of tibia. | |
| 7. Wing membrane attached to side of foot (not ankle); fur of back with obviously darkened basal area; length of foot less than 58 per cent of length of tibia. | |
| 8. Fur of back without obvious tricolor pattern; calcar normally with no trace of keel. | |
| 9. Ear when laid forward not extending noticeably beyond tip of muzzle. | |
| 10. Cheek-teeth narrow compared with palatal expance between molars of two sides of upper jaw (see fig. 6a) | |
| Big Myotis, page 28 | |
| 10'. Cheek-teeth wide compared with palatal expance between molars of two sides of upper jaw (see fig. 6c) | |
| Cave Myotis, page 31 | |
| 9'. Ear when laid forward extending noticeably beyond tip of muzzle | |
| Keen's Myotis, page 33 | |
| 8'. Fur of back with obvious tricolor pattern; calcar normally with small but evident keel . . . (not yet detected in Kansas) Social Myotis, page 246 | |
| 7. Wing membrane attached to tarsus; fur of back without obviously darkened basal area; length of foot normally about 60 per cent of length of tibia
(not yet detected in Kansas) Gray Myotis, page 246 | |
| 6'. Length of foot 40 to 46 per cent of length of tibia | |
| Small-footed Myotis, page 32 | |
| 5'. Tip of tail extending slightly beyond interfemoral membrane; total length more than 105; 32 teeth | |
| Big Brown Bat, page 36 | |
| 4'. Dorsal surface of interfemoral membrane furred for from $\frac{1}{2}$ to $\frac{1}{3}$ of its length; 34 or 36 teeth | |
| 11. Pelage yellowish brown; forearm shorter than 36; 34 teeth | |
| Pipistrelle, page 34 | |
| 11'. Pelage sooty, frosted with white; forearm longer than 36; 36 teeth | |
| Silvery-haired Bat, page 40 | |

3'. One upper incisor on each side.	
12. Upper surface of interfemoral membrane entirely bare or furred slightly at extreme base; 30 teeth .. Evening Bat, page	38
12'. Upper surface of interfemoral membrane completely furred; 32 teeth.	
13. Pelage brownish-black overcast with white; inside of pinna of ear densely furred; total length more than 120; forearm more than 50; breadth of braincase more than 8.6 Hoary Bat, page	42
13'. Pelage reddish or yellowish; inside of pinna of ear naked; total length less than 120; forearm less than 50; breadth of braincase less than 8.6 Red Bat, page	44
2'. Ear from notch more than 20.	
14. Prominent glandular swelling on each side of muzzle; forearm less than 49; incisors, $\frac{2}{3}$; premolars, $\frac{2}{3}$ Long-eared Bat, page	46
14'. No swelling on side of muzzle; forearm more than 49; incisors, $\frac{1}{2}$; premolars, $\frac{1}{2}$ Pallid Bat, page	48
1'. Tail extending behind uropatagium for half the length of the tail; anterior border of ear with six to eight horny excrescences; anterior border of palate with a distinct emargination.	
15. No pocket in membrane at angle formed by tibia and femur; ears when laid forward not extending beyond nose; two and generally three incisors on each side below; condylobasal length of skull less than 18 Brasilian Free-tailed Bat, page	50
15'. Well-developed pocket in membrane at angle formed by tibia and femur; ears when laid forward extending beyond nose; two incisors on each side below; condylobasal length of skull more than 18 Big Free-tailed Bat, page	52

FAMILY VESPERTILIONIDAE

Little Brown Bats

Genus *Myotis* Kaup

Four species of little brown bats, or mouse-eared bats as they have been called, are recorded from Kansas. Each species is brownish and has a dental formula of i. $\frac{2}{3}$; c. $\frac{1}{1}$; p. $\frac{3}{3}$; m. $\frac{3}{3}$. None is truly migratory although the summer and winter homes often are long distances apart. Each species is gregarious, especially in winter. Two other species, *Myotis sodalis* and *Myotis grisescens*, are to be looked for in the southeastern part of the State but have not been taken in Kansas at this writing (March 2, 1955). Because I have unsuccessfully sought them there in mine tunnels in winter, I have it in mind to search for them in that area in summer on the chance that they really live there at seasons when insect food is available but return to their ancestral hibernation quarters somewhere to the south or east when cold weather comes on.

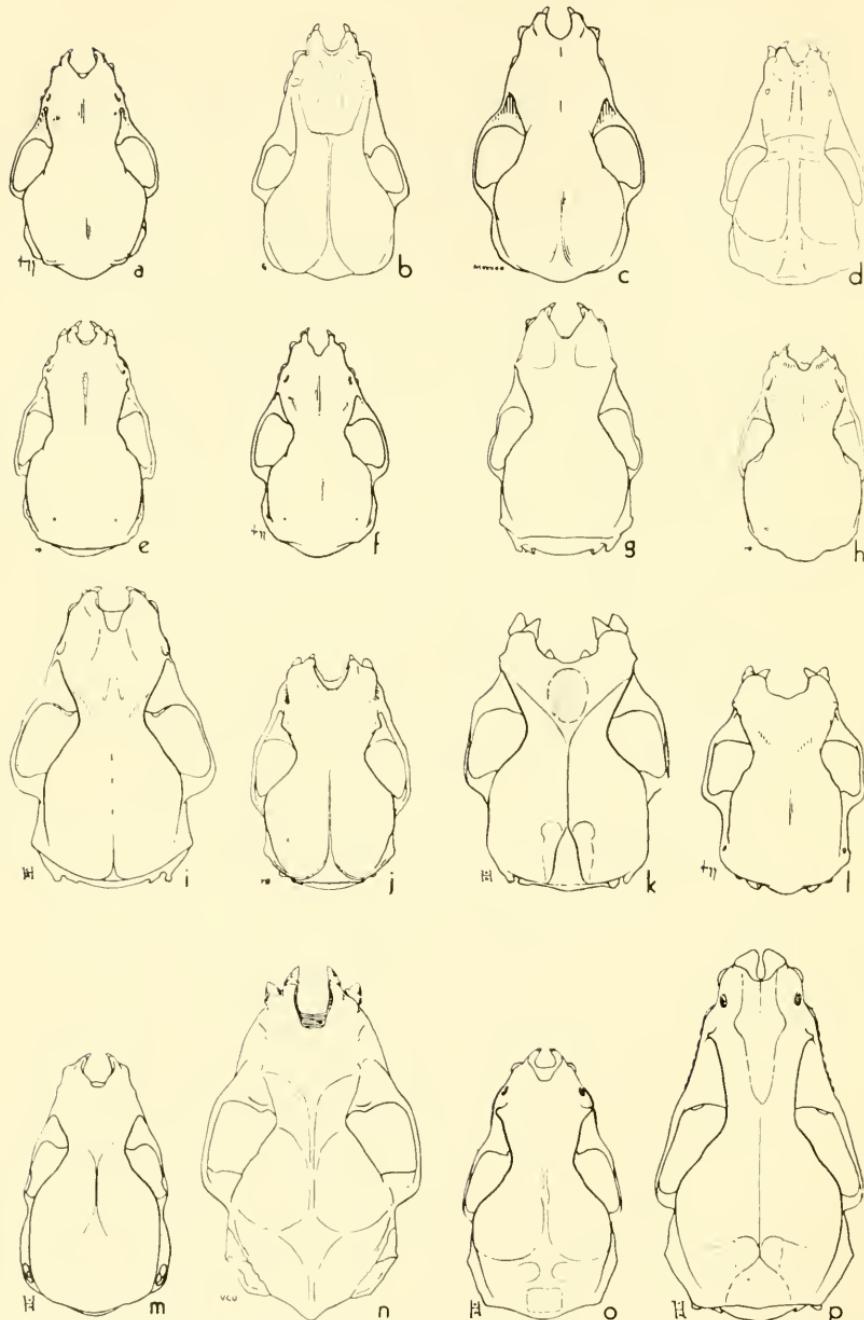


FIG. 5. Dorsal views of skulls of bats. All $\times 2$. (Other views of these skulls are shown in figs. 6 and 7.)

- a. *Myotis lucifugus*
- b. *Myotis grisescens*
- c. *Myotis velifer*
- d. *Myotis keeni*
- e. *Myotis sodalis*
- f. *Myotis subulatus*
- g. *Lasionycteris noctivagans*
- h. *Pipistrellus subflavus*
- i. *Eptesicus fuscus*
- j. *Nycticeius humeralis*
- k. *Lasiurus cinereus*
- l. *Lasiurus borealis*
- m. *Corynorhinus townsendii*
- n. *Antrozous bunkeri*
- o. *Tadarida brasiliensis*
- p. *Tadarida molossa*

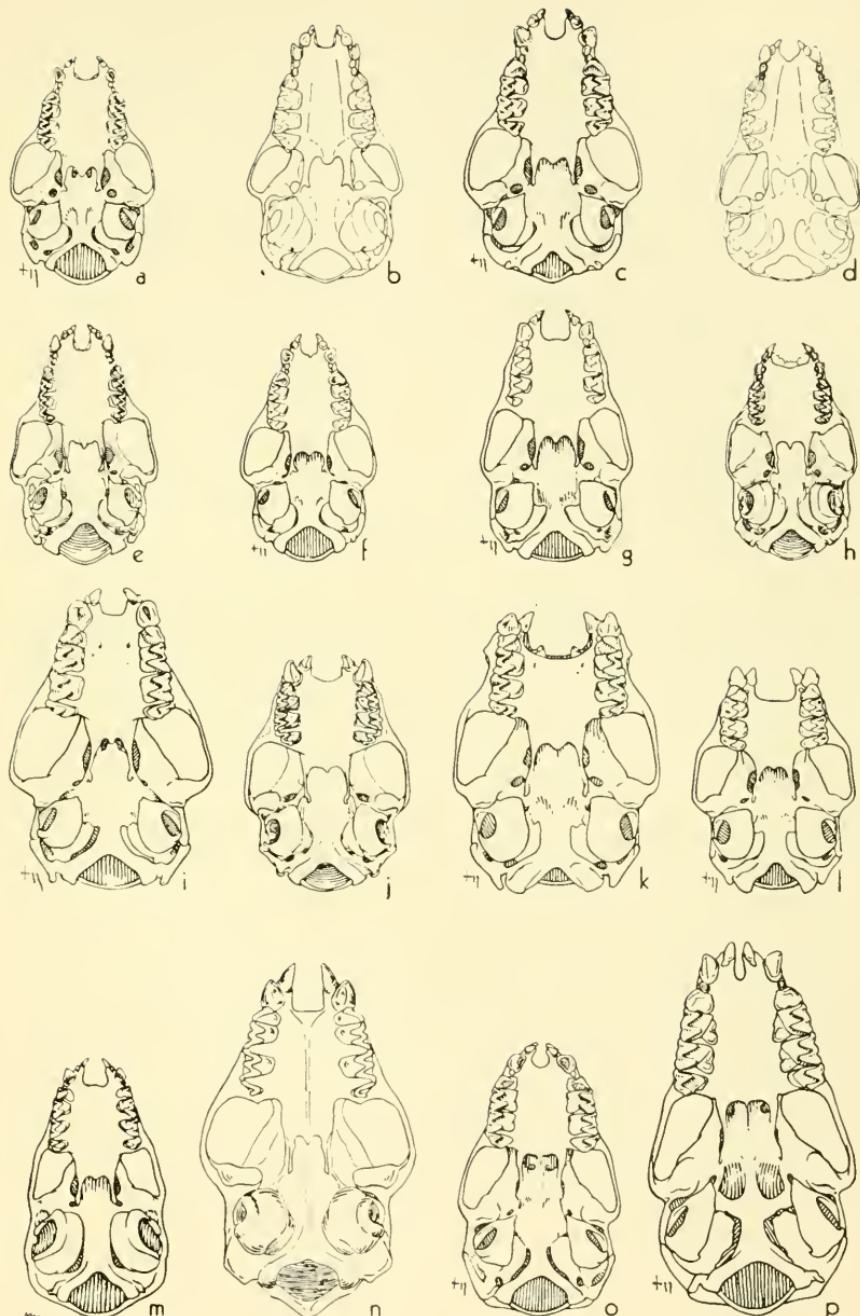
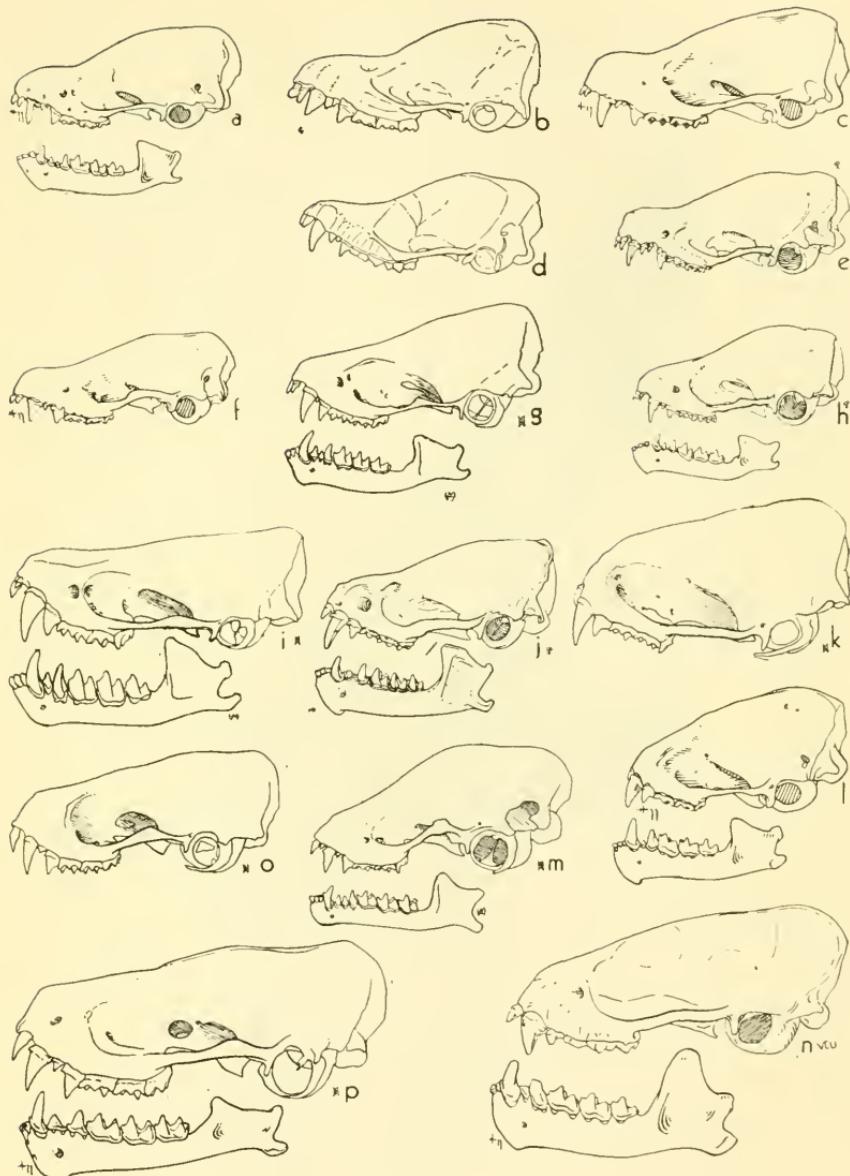


FIG. 6. Ventral views of skulls of bats. All $\times 2$. (Other views of these skulls are shown in figs. 5 and 7.)

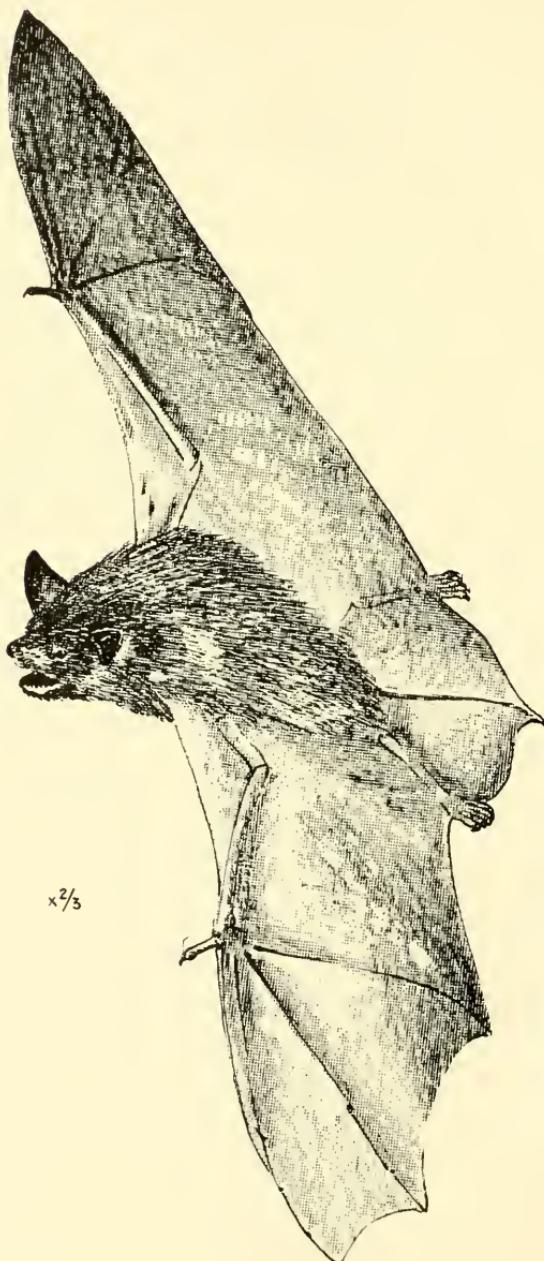
- a. *Myotis lucifugus*
- b. *Myotis grisescens*
- c. *Myotis velifer*
- d. *Myotis keeni*
- e. *Myotis sodalis*
- f. *Myotis subulatus*
- g. *Lasionycteris noctivagans*
- h. *Pipistrellus subflavus*
- i. *Eptesicus fuscus*
- j. *Nycticeius humeralis*
- k. *Lasiurus cinereus*
- l. *Lasiurus borealis*
- m. *Corynorhinus townsendii*
- n. *Antrozous bunkeri*
- o. *Tadarida brasiliensis*
- p. *Tadarida molossa*

FIG. 7. Lateral views of skulls of bats, all $\times 2$.

- a. Big Myotis, *Myotis lucifugus lucifugus* (Le Conte), 1½ mi. W and ¼ mi. N Blue Rapids, Marshall Co., Kansas, ♂, No. 44694KU.
- b. Gray Myotis, *Myotis grisescens* A. H. Howell, Hunters Cave (= Kelly Cave), Boone Co., Missouri, ♂, No. 63095MVZ.
- c. Cave Myotis, *Myotis velifer incautus* (J. A. Allen), Havard Cave, 4½ mi. SW Sun City, Barber Co., Kansas, ♂, No. 9713KU.
- d. Keen's Myotis, *Myotis keeni septentrionalis* (Trouessart), Crystal Cave, 5 mi. N Bentonville, Benton Co., Arkansas, ♀, No. 83535MVZ.
- e. Social Myotis, *Myotis sodalis* Miller and Allen, White Rock Camp, ½ mi. E Fifty six, Stone Co., Arkansas, ♀, No. 47581MVZ.
- f. Small-foot Myotis, *Myotis subulatus subulatus* (Say), 5 mi. W Elkader, Logan Co., Kansas, ♂, No. 5561KU.
- g. Silvery-haired Bat, *Lasionycteris noctivagans* (Le Conte), 4 mi. W Fallon, 4000 ft., Churchill Co., Nevada, ♂, No. 88058MVZ.
- h. Pipistrelle, *Pipistrellus subflavus subflavus* (F. Cuvier), Bat Cave, 2 mi. N War Eagle, Benton Co., Arkansas, ♀, No. 81387MVZ, but lower jaw from a cave along Missouri River 1 mi. SE Leavenworth, Leavenworth Co., Kansas, ♂, No. 38797KU.
- i. Big Brown Bat, *Eptesicus fuscus pallidus* Young, E slope Irish Mtn., 6900 ft., Lincoln Co., Nevada, ♂, No. 47851MVZ.
- j. Evening Bat, *Nycticeius humeralis* (Rafinesque), St. Andrews Parish, Charleston Co., South Carolina, ♂, No. 97176MVZ.
- k. Hoary Bat, *Lasiurus cinereus cinereus* (Beauvois), Camp Verdi, Yavapai Co., Arizona, ♀, No. 71588MVZ.
- l. Red Bat, *Lasiurus borealis borealis* (Müller), ½ mi. S Galena, Cherokee Co., Kansas, ♀, No. 38813KU.
- m. Long-eared Bat, *Corynorhinus townsendii pallescens* Miller, 7 mi. S Cleveland Ranch, 6000 ft., White Pine Co., Nevada, ♂, No. 45899MVZ.
- n. Brazilian Free-tailed Bat, *Tadarida brasiliensis mexicana* (Saussure), Green Monster Canyon, Monitor Range, 7500 ft., Nye Co., Nevada, ♂, No. 57472MVZ.
- o. Big Free-tailed Bat, *Tadarida molossa* (Pallas), Pine Canyon, 6000 ft., Chisos Mts., Brewster Co., Texas, ♀, No. 81683MVZ.
- p. Pallid Bat, *Antrozous bunkeri* Hibbard, Natural Bridge, Barber Co., Kansas, ♀, No. 9302KU.



Big Myotis

Myotis lucifugus (Le Conte)

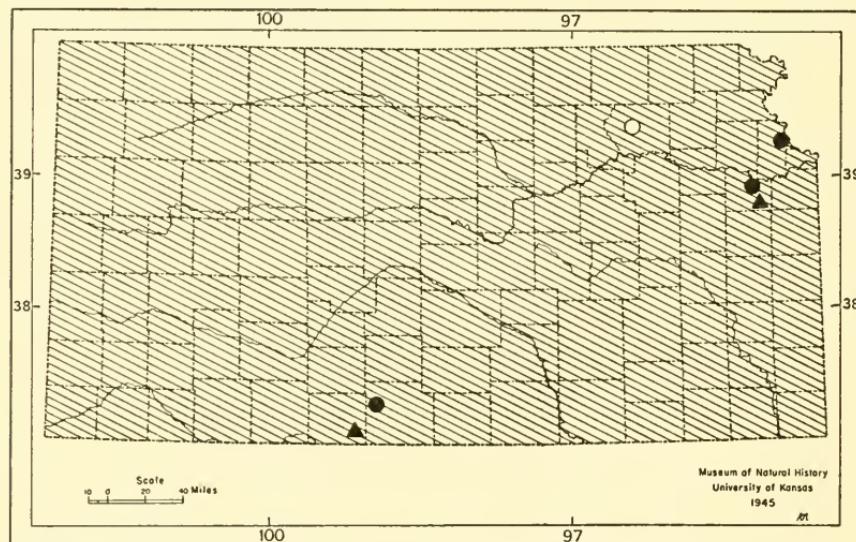
Females, in summer, live in colonies in shallow caves, attics of buildings and probably under rock ledges and in hollow trees. Males are not associated with the females in spring and summer and seem not to be colonial. In winter, males and females occur together, hibernating in caves where the humidity is high and where the temperature is above freezing. There is only one young per female per year. One individual lived for at least 13 years.

This was the principal species used by two graduate students at Harvard in 1940 when they experimented to learn how flying bats avoid stationary objects. The bats were made to fly through a barrier of vertical wires while a suitable amplifier and thermionic device recorded the supersonics (sounds too high for the ear of Man to hear) in sound audible to the human ear; at the same time the supersonics were recorded on a paper tape. It was found that an active bat emits sound frequencies throughout the region of 30 to 70 kilocycles. Of all these, the frequencies near 50 kilocycles are the most intense. Emission is in the form of discreet bursts, each lasting about 1/50th of a second. Resting bats emit approximately 5 bursts per second; bats flying in unobstructed space emit 25 to 35 bursts; bats approaching obstacles emit 50 to 60 bursts. A marked drop occurs in the rate of emission of supersonic bursts immediately before bats dodge obstacles. This is true in 90 per cent of such cases. A similar change in rate occurs in only 20 per cent of the cases where bats strike obstacles.

When flying through the vertical wires mentioned above, hits were scored in 37 per cent of the cases. Covering the eyes of the bats made no difference in percentage of hits or in flight. Covering the ears resulted in slowed flight and frequent collisions with hits then rising to 65 to 70 per cent which was approximately chance average. Controls showed that this effect was not due to injury or irritation. Equally serious impairment of flight and also impaired ability to avoid obstacles resulted when a bat's mouth was covered so that no supersonic sound could escape. Bats with only one ear covered avoided walls and large obstacles but struck the wires and other small objects as often as did bats with both ears covered.

Conclusions were that flying bats detected obstacles by (1) emitting supersonic cries, (2) hearing these sound waves reflected back to them by the obstacles, and (3) localizing the source of reflected sound by an auditory mechanism presumably similar to that used by other mammals for sounds audible to them.

More specimens of this bat probably could be taken if their drinking places were located and fine wires were stretched three to four inches above the water. At any rate this arrangement has proved to be successful in capturing several related species in the deserts of Nevada and Arizona. A bat swoops down and scoops up a drink by means of the lower jaw. The wire is an obstacle that some of the bats strike with the result that they fall into the water. As they swim toward the bank they can be caught easily by hand. To avoid being bitten the collector needs to wear gloves or must grasp the bat in such a fashion that it cannot sink its teeth into his fingers.



The range probably is state-wide.

Description.—Total length, 75-91; tail, 29-40; hind foot, 8-10; ear from notch, 12-15; weight, 5 to 6 ounces. Glossy yellowish brown to olive brown above with a distinct sheen; lighter, chamois, below; ear, when laid forward, reaching approximately to end of nose; forearm less than 41.5; third metacarpal longest and when folded falling short of elbow by approximately 2.5; greatest length of skull less than 16.5 (14.1-15.1); interorbital constriction, 4.0-4.3; maxillary breadth at M₃, 5.4-6.1.

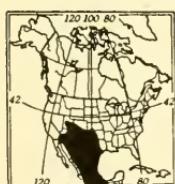
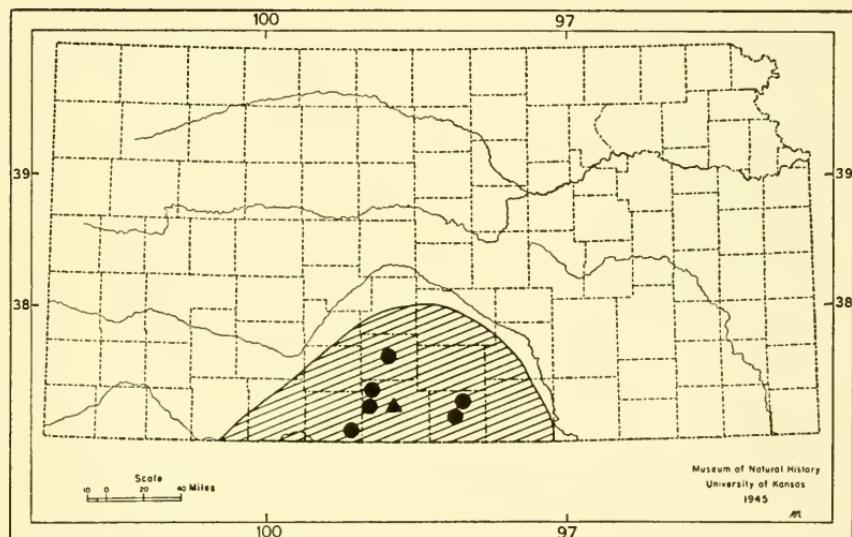
Myotis lucifugus lucifugus is the only subspecies recorded from Kansas, and was named by Le Conte (McMurtrie's Animal Kingdom, 1:431, 1831) with type locality in Georgia, probably on the Le Conte Plantation near Riceboro.

After the map, showing the localities of known occurrence of this bat in Kansas was prepared, specimens for the University of Kansas Museum of Natural History were obtained from one and one half miles west and one half mile north of Blue Rapids in Marshall County (see Jones, Loomis, Krutzsch and Webb, Trans. Kansas Acad. Sci., 55:312, October 31, 1952).

Cave Myotis

Myotis velifer (J. A. Allen)

In McMoran Cave several thousand of these bats were found in crevices in the ceiling and hanging from the ceiling in clusters of two to several hundred individuals. These were found at 8:30 p. m. on March 26, 1948, 17 miles east and 14 miles south of Coldwater. The bats were torpid but when disturbed they began to breathe rapidly and many later flew away. Two thousand of the bats were banded by Cockrum and his companions. In the succeeding seven months six of the bats were recovered at distances of up to 43 miles from the cave.



In south-central Kansas this species has been found north to Pratt, west to a place 6 mi. NW Aetna in Comanche County, and east to Harper in Harper County.

Description.—Total length, 105; tail, 46; hind foot, 11; ear from notch, 16. Color of upper parts uniformly dull sepia or drab; underparts somewhat paler but with bases of hairs everywhere dark except at sides of belly where hairs are whitish throughout; ear when laid forward reaching approximately to nostril; forearm averaging more than 41.5 (39.0-43.0); third and fourth metacarpals usually subequal; third metacarpal, when folded, falls short of elbow by approximately 2.5 mm.; greatest length of skull more than 15.9 (16.0-17.6); interorbital constriction, 3.8-4.5; maxillary breadth at M3, 6.8-7.3.

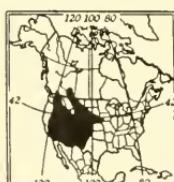
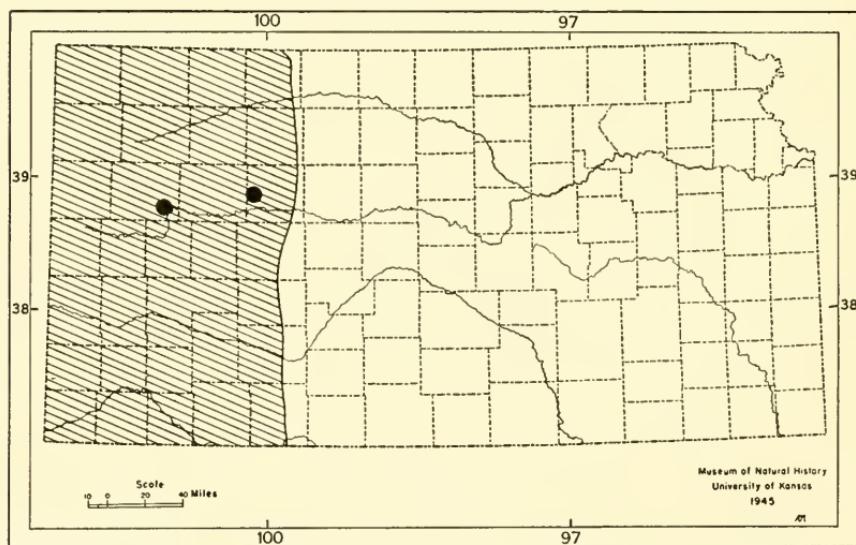
Myotis velifer incautus, the one subspecies in Kansas, was named by J. A. Allen (Bull. Amer. Mus. Nat. Hist., 8:239, November 21, 1896) with type locality at San Antonio, Bexar County, Texas.

Small-footed Myotis

Myotis subulatus (Say)

The stomachs of two collected at late dusk in Logan County contained bugs (Jassidae), flies (Anthomyidae), *Agallia*, *Piesma cinerea*, minute Scarabaeidae, Staphylinidae, Anthicidae and fragments of ants (see Cockrum, 1952:62). In North Dakota this species was found to have two young, twice as many as most other *Myotis*.

Bats were much used in past times as ingredients of concoctions having 'magical' effects. For example, it is written that the dried head of a bat, if placed under a person's pillow will prevent him from going to sleep. An ancient method of preventing the growing of eyelashes after they had been pulled out was to apply to the eyes an ointment made of bat's blood, ground potsherd, and honey.



In Kansas the species has been taken only in the western third of the State in Logan (5 mi. W Elkader) and Trego (Banner, and Castle Rock on Hackberry Creek) counties.

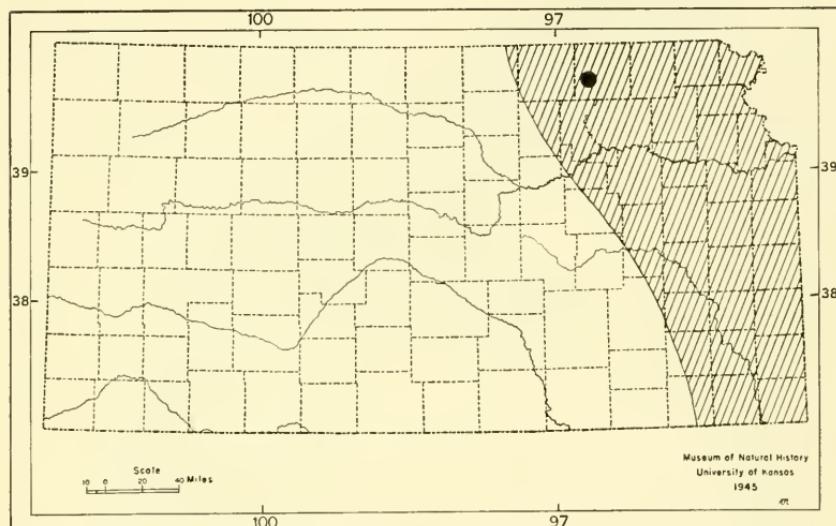
Description.—Total length, 78-79; tail, 35-42; hind foot, 7-8; ear from notch, 15-18. Fur flaxen or yellow at tips imparting a burnished effect; face and ears black, ear, when laid forward, reaching to tip of snout or 1 mm. beyond; forearm, 31.6-34.4; third metacarpal slightly longer than fourth or than fifth and, when folded, falls short of elbow by approximately 1 mm.; greatest length of skull less than 16.5 (13.6-14.7); interorbital constriction, 3.0-3.6; maxillary breadth at M₃, 5.0-5.6.

Myotis subulatus subulatus, the one subspecies that occurs in Kansas, was named by Say (Long's Expedit. to Rocky Mts., 2:65 [footnote], 1823) with type locality along the Arkansas River near La Junta, Otero County, Colorado.

Keen's Myotis

Myotis keeni (Merriam)

The population of this bat, as is the case with most species of bats, is maintained by the birth of only one or two young per female each year, whereas nearly all other kinds of small mammals produce a larger number of young to maintain their populations.



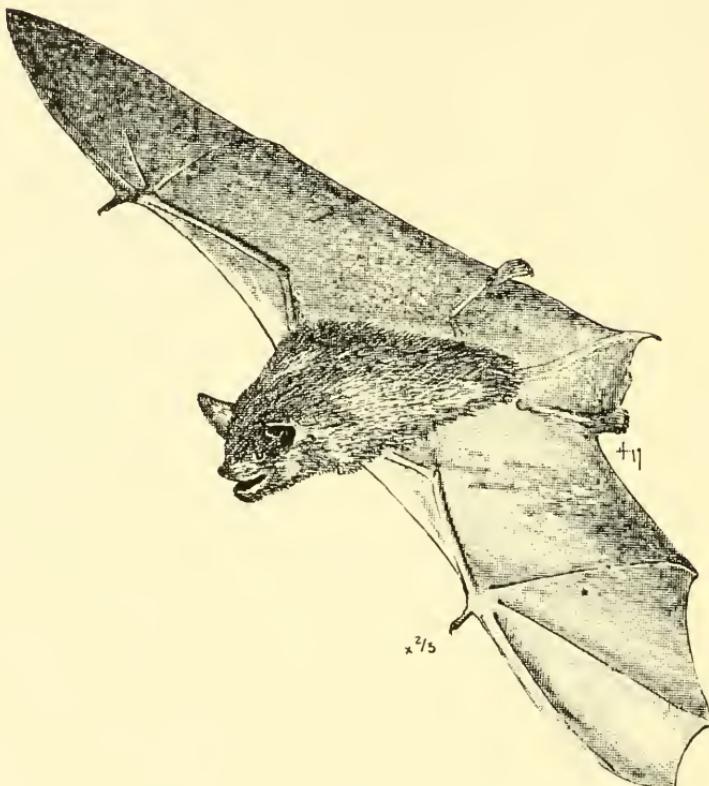
In Kansas this bat has been taken only in an abandoned mine on the south bank of the Little Blue River, $1\frac{1}{2}$ mi. W and $\frac{1}{2}$ mi. N Blue Rapids, Marshall County, on December 28, 1951. These bats were hibernating there (see Jones, Loomis, Krutzsch and Webb, Trans. Kansas Acad. Sci., 55:312, October 31, 1952).

Description.—Total length, 78.2-84.0; tail, 35.2-42.2; hind foot, 7.2-9.0; ear from notch, 14.2-17.2. Yellowish brown to olive brown above with less glossy effect than in *Myotis lucifugus*; lighter, chamois, below; ear, when laid forward, reaching approximately 4 mm. beyond end of nose; forearm, 34.6-38.8; metacarpals 3.4 and 5 almost equal in length but when folded, third metacarpal falls 2 mm. short of elbow; greatest length of skull, 14.6-15.6; interorbital constriction, 3.4-3.8; maxillary breadth at M3, 5.3-6.4. Differs from *M. lucifugus* as follows: back usually less glossy; ear longer; skull narrower in proportion to its length; distance from tip of hamular process of pterygoid to last molar more than (instead of equal to) distance between last molars; length of maxillary tooth-row more, instead of less, than palatal width including upper molars.

Myotis keeni septentrionalis, the one subspecies that occurs in Kansas, was named by the well-known French mammalogist, Trouessart (Catalogus Mammalia . . . , 131, 1897), with type locality at Halifax, Nova Scotia.

Genus *Pipistrellus* Kaup

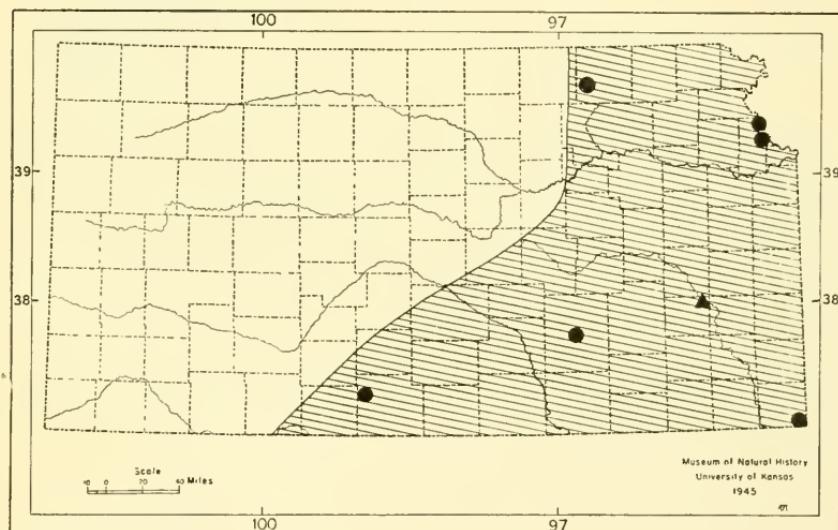
Pipistrelle

Pipistrellus subflavus (F. Cuvier)

This is the smallest bat in Kansas, and concerning it Cockrum writes essentially as follows: This species is confined to the eastern part of North America where it ranges from Quebec, Canada, southward to Honduras in Central America. The species hibernates in caves, in winter, at least in the northern part of its range. Usually, the pipistrelle selects warm, draftless places for hibernating in clusters of less than 50 individuals. Sometimes the hibernating individuals occur singly. Since the places chosen for hibernation may be moist, the bats may be almost covered with droplets of water, which reflect light and make beautiful objects of the bats that seem, under such circumstances, to be frosted. Individuals may enter upon hibernation, in Missouri, in October and both sexes, in approximately equal numbers, remain until the end of April. By May only males remain and they feed throughout that month. Between May and

October both sexes live elsewhere than in the cave. The species seems not to be migratory but in New York State a distance of 65 miles intervened between the sites of capture of a banded individual.

The Pipistrelle, like each of the other species of bats in Kansas, feeds on insects. These are crepuscular (active at twilight) and nocturnal insects. Our bats fly only at these times and take their food on the wing. The bats complement the birds in forming a natural check on the number of insects; the birds, as a group, prey on the diurnal insects and the bats on the nocturnal insects. Also, a fact seldom appreciated is that the total number of bats of the several species approximates the total number of birds in any area of eastern Kansas. Consequently the bats, which work the night-shift, may be quite as valuable an ally of man in his battle against crop-destroying insects as are the birds which work the day-shift.

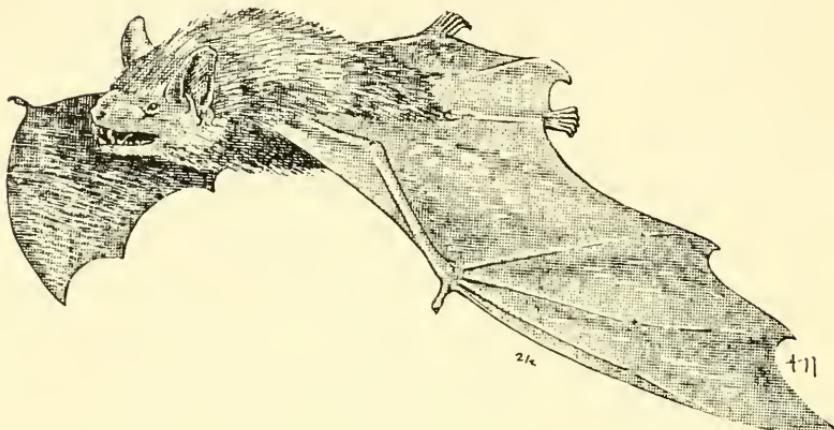


Two record stations of occurrence are a cave $1\frac{1}{2}$ mi. W and $\frac{1}{2}$ mi N of Blue Rapids (Marshall Co.) and a cave $5\frac{1}{2}$ mi. SW Sun City (Barber Co.). Known occurrences otherwise are south and east of a line drawn between these two caves.

Description.—Total length, 77-89; tail, 39-43; hind foot, 9-11; ear from notch, 13-14. Pelage brownish (Sayal Brown to Mummy Brown or darker); ears and membranes naked; foot more than half as long as tibia; tragus tapering and straight; dorsal profile of skull convex in interorbital region; dental formula, i. $\frac{2}{3}$; c. $\frac{1}{1}$; p. $\frac{2}{2}$; m. $\frac{3}{3}$.

Only one subspecies, *Pipistrellus subflavus subflavus*, occurs in Kansas and it was named by F. Cuvier (Nouv. Ann. Mus. Nat. Hist., Paris, 1:17, 1832) on the basis of specimens from the eastern United States, probably from Georgia.

Genus *Eptesicus* Rafinesque
Big Brown Bat
Eptesicus fuscus (Beauvois)



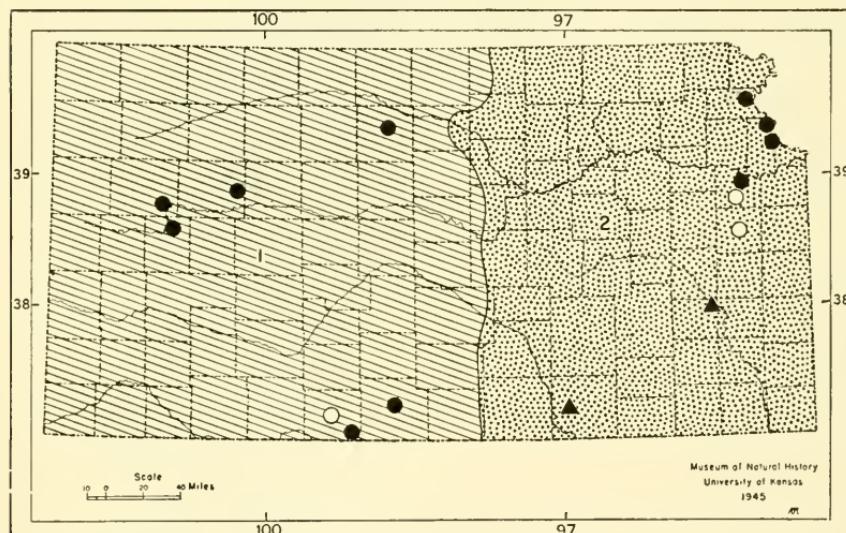
In winter this species has been found in mines and in buildings. Two places where wintering individuals have been found at Lawrence, Kansas, are the storm sewers, and a narrow slit between a rafter and the siding of the dairy barn at Haskell Institute. In summer, colonies composed entirely of females have been found in buildings. One young per female is all that I have noted. One individual lived for at least nine years.

This species has been successfully kept in captivity by feeding it meal worms and other insects. The Big Brown Bat seems to be hardier than his cousins, the little brown bats; anyhow many Big Brown Bats spend the winter in places where the little brown bats can not survive because there is insufficient moisture or because the temperature drops too low.

Collectors of bats use a net of finest silk with meshes half an inch or so across. Many kinds of bats will strike such a net and entangle a wing. If a person stands beside the net with a flashlight he can capture the bats before they disentangle themselves. One such net that I stretched across a trail in the tropical jungle of Panamá functioned efficiently for me until I left it unattended. Then some large bats flew through, or with their teeth cut through, the net and left three gaping holes in it. After that none of the bats of any kind became enmeshed. I suppose that the "radar mechanism" of the flying bats warned them of the inequality of the surface that they were approaching and caused them to veer aside or over or under the net.

whereas the uniform surface of the undamaged net aroused in the flying bats only a slight indecision and some struck the net.

This bat sometimes enters houses at night through unscreened windows or doors. Probably such bats are seeking insects—some of those attracted to the lights—and do no harm but many women believe, or profess to believe, that bats delight in entangling themselves in women's hair. Such is not at all the case but it would be possible, I suppose, for a bat that was swooping after a flying insect to come close enough to a lady's head to become entangled in her hair. In a part of France there is said to be a belief that bats fly near a person's head with the evil purpose of transferring lice to the person's hair. The facts are that kinds of lice that live on bats cannot live on persons and *vice versa*. Likewise, the kinds of bedbug-like insects that live on some bats cannot live on persons.



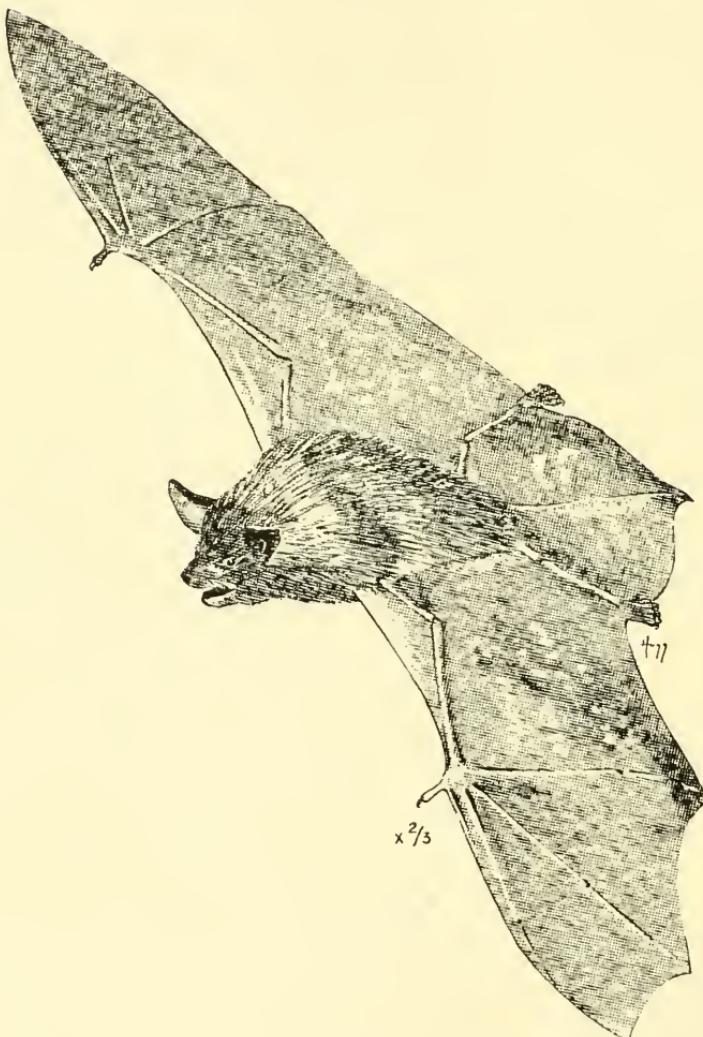
Distribution of *Eptesicus fuscus*.
1. *E. f. pallidus*. 2. *E. f. fuscus*.

Description.—Total length, 110-117; tail, 40-54; hind foot, 9-12; ear from notch, 14-19; weight, 14-19 grams. Uniformly dark brown; ears and membranes black; dental formula, i. $\frac{2}{3}$; c. $\frac{1}{1}$; p. $\frac{1}{2}$; m. $\frac{3}{3}$; greatest length of skull, 17.7-19.4 mm.; width across zygomatic arches, 12.4-13.1.

In Kansas there are two subspecies: *Eptesicus fuscus fuscus*, named by Beauvois (Catal. Raisonné Mus. Peale, p. 18, 1796) with type locality at Philadelphia, Pennsylvania, and in the western three-fifths of the State, *Eptesicus fuscus pallidus*, named by Young (Proc. Acad. Nat. Sci., Philadelphia, 60:408, 1908) with type locality at Boulder, Boulder County, Colorado.

Genus *Nycticeius* Rafinesque

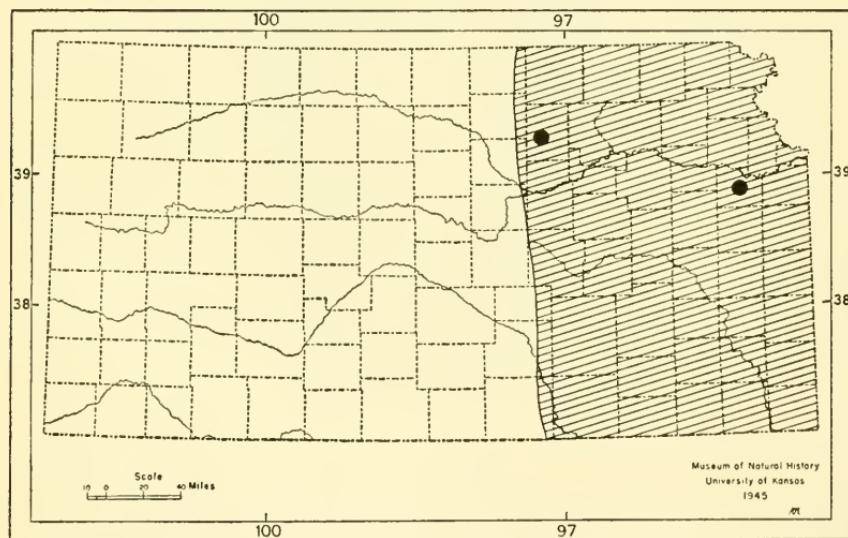
Evening Bat

Nycticeius humeralis (Rafinesque)

The Evening Bat is easily mistaken for *Myotis lucifugus* but has fewer teeth. These, however, are of the high-cusped variety common to all members of the family Vespertilionidae. The molar teeth have all five cusps characteristic of the mammalian tooth and each upper molar of this bat is provided, in addition, with styles (accessory cusps), the whole forming an efficient masticatory apparatus.

for hard-shelled insects. The cheek-teeth of the deciduous (milk) dentition of this species are described as spikelike but with recurved tips, the better to aid the young bat to cling to the fur of the mother. This is true of the deciduous cheek-teeth of all of the vespertilionid bats. In some kinds of bats some of the milk teeth have bifid tips.

Thinking now of the permanent dentition of bats, the Evening Bat has next to the fewest teeth, 30, of all of the bats that occur in Kansas; the Pallid Bat has the fewest, only 28. In the Order Chiroptera as a whole the number of teeth in a full set, depending on the species, varies from as few as 20 in the vampire bats to as many as 38 in the genus *Myotis*. No bat has the full complement, for mammals, of 44 teeth. In the fruit bats, suborder Megachiroptera, the molar teeth of several species lack nearly all traces of the cusps, which were a part of the primitive structure.



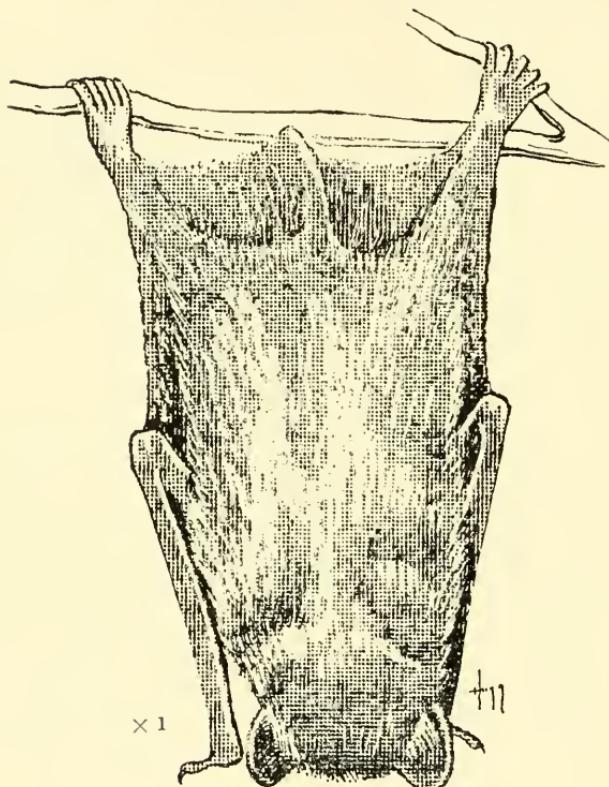
This species has been taken as far west as a point 6 mi. SW Clay Center.

Description.—Total length, 85-99; tail, 35-37; hind foot, 6.7-7.3; ear from notch, 12.7-13.9; weight, 15-16 grams; forearm, 34-38. Pelage dull brownish, slightly lighter beneath; hair on dorsum short, approximately 6 mm.; ears and membranes naked; skull 14 mm. long, 10 mm wide, and dorsal profile nearly straight; dental formula, $i.\frac{1}{1}; c.\frac{1}{1}; p.\frac{1}{2}; m.\frac{3}{3}$.

Nycticeius humeralis humeralis is the only subspecies that occurs in Kansas and was named by Rafinesque (Amer. Monthly Magazine, 3:445, October, 1818) with type locality somewhere in the state of Kentucky.

Genus *Lasionycteris* Peters

Silvery-haired Bat

Lasionycteris noctivagans (Le Conte)

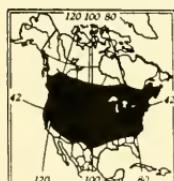
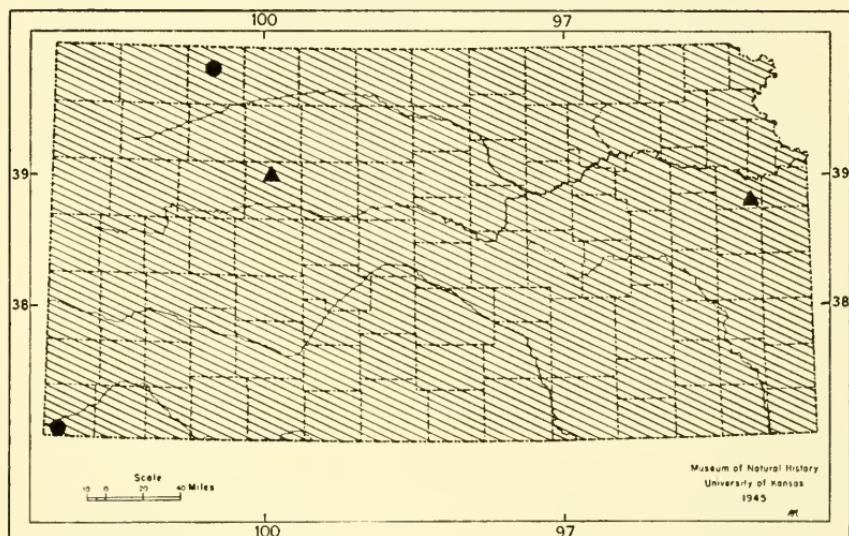
The silvery cast to the pelage is reminiscent of that in the much larger Hoary Bat, *Lasiurus cinereus*. The Silvery-haired Bat differs further in black, rather than brownish, color of the basal part of the fur, and in naked, instead of densely haired, inner surface of the ear and distal half of the upper surface of the interfemoral membrane.

The Silvery-haired Bat is solitary and usually lives in trees. It migrates from its more northern summer haunts to winter quarters south of Kansas, and returns north again in the spring. The usual number of young is two at a birth; less commonly there is only one.

It has been said that bats are our nearest living relatives. This seems to be true if we interpret "our" as meaning not only Man but also the monkeys, apes and the small fossil monkeys known only from their bones and teeth in deposits of Eocene Age. These small fossil creatures of man's family tree were so similar to the bats in the

structure of their teeth and skulls as to suggest that bats and these early primates were descended from a common ancestor. While Man was evolving from these early primates, the bats retained much of the original structure of the base of the skull and of their teeth and so have come down to the present day with these parts but little changed. Viewed in this way bats may be our near relatives.

The palaeontological record has not yet revealed the successive steps that lead from the small ancestral land mammal, through the supposed climbing and then gliding stage to the final stage of actual flight. It is a reasonable guess that this adaptation to flight was accomplished because there was a little-used food source, twilight-flying insects, available for use.



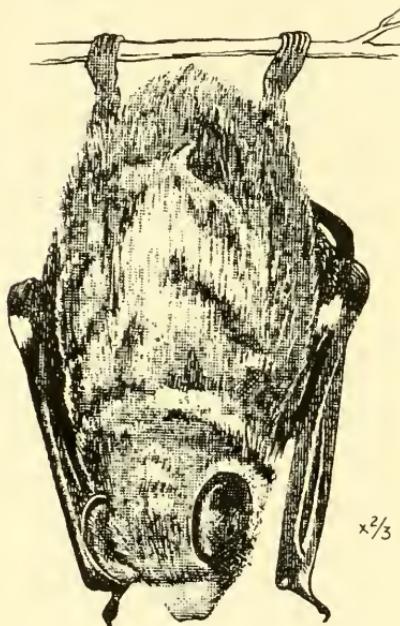
The Silvery-haired Bat probably migrates through all parts of the State on its southward flight in autumn and on its northward flight in spring; so far as known none remains in the State in winter or in summer.

Description.—Total length, 95-108; tail, 31-46; hind foot, 8-10; ear from notch, 11-14. Weight, 6.8-11.4 grams. Black with some hairs on both upper parts and underparts tipped with white; ears and membranes black and naked except for basal half of interfemoral membrane; third metacarpal, when folded back, falling about equal with elbow; skull flattened, especially in rostral region, where there is a distinct concavity on each side between lacrimal bone and anterior nares; dental formula, $i.\frac{2}{3}; c.\frac{1}{1}; p.\frac{2}{3}; m.\frac{3}{3}$.

The species *Lasionycteris noctivagans* is confined to North America and is remarkably uniform—so much so that no subspecies of it have been distinguished. The species was named by Le Conte (McMurtrie's Animal Kingdom, 1:431, 1831) from individuals taken in the eastern part of the United States.

Genus *Lasiurus* Gray

Hoary Bat

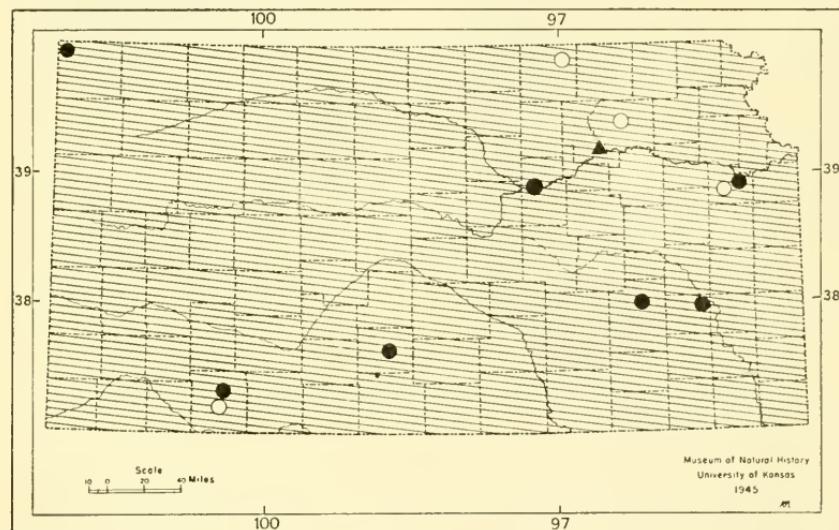
Lasiurus cinereus (Beauvois)

This solitary, tree-living species lives in Kansas in summer but migrates in autumn to more southern areas and spends the winter there. In the northward migration, females seem to precede males. Two is the usual number of young. In my experience the Hoary Bat emerges in evening later than several of our other species of bats—it appears first when the last of twilight is giving way to night and continues foraging after dark. Persons who closely observe bats that are in flight come to recognize the Hoary Bat by its relatively large size, long narrow pointed wings, and swift flight. This bat is much less abundant than the Red Bat or Big Brown Bat and the naturalist who collects mammals always is elated when he obtains a Hoary Bat, partly because of the rarity of the species and partly because of the beauty of the specimen.

The uncertainty in many persons' minds about the correct zoological position of bats is reflected in an ancient fable, from before the time of Christ. This fable, according to the late Dr. Glover M. Allen, relates to an ancient tradition of a war between the birds and the beasts, in which each party was by turns victorious. A bat, fearful

of the outcome of the struggle, always associated with the stronger side. But, when peace was at length declared, neither of the opposing parties would receive him because of his deceitful conduct, so that he was driven from the light of day and ever afterward forced to hide in dark places, whence he might issue only at night and alone. The moral of course is that "those who practice deceit must expect to be shunned."

We, nevertheless, know each of the fourteen kinds of bats in Kansas as a beneficial eater of insects. Most insectivorous birds are active only in daytime. At dusk, the bats begin the night shift and are one of the principal checks on night-flying insects.



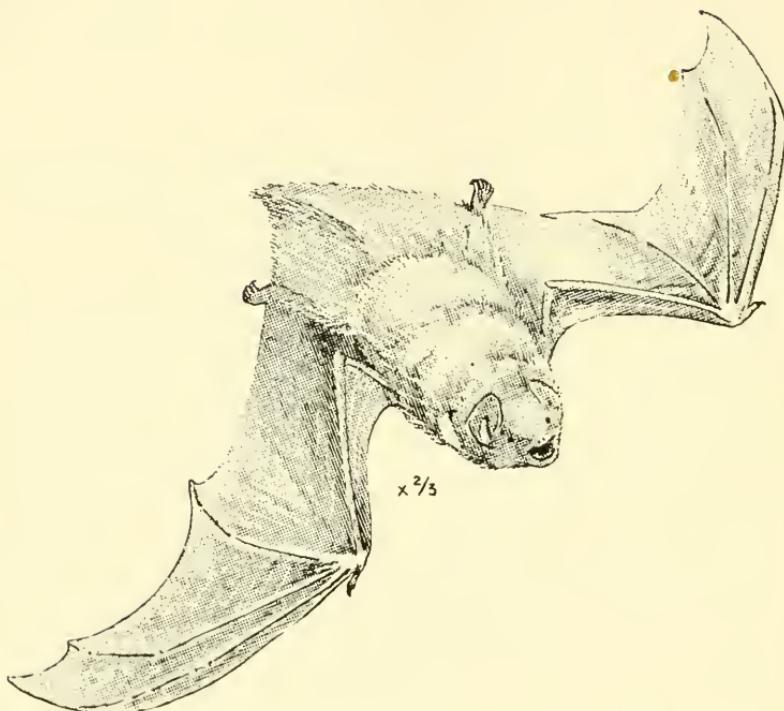
The northwesternmost record is provided by a specimen sent to the University of Kansas Museum of Natural History by Mr. Charles Vanderford who obtained the bat 12½ mi. N and 5½ mi. W St. Francis. The range is state-wide.

Description.—Total length, 126-150; tail, 48-65; hind foot, 11-14; ear from notch, 13-18; weight, 23-27 grams.

Pelage brownish black overcast with white, giving an appearance, at first glance, of being overcast with hoarfrost; white tips of hairs succeeded by dark brownish band; light yellowish band, and basal band of blackish or dark plumbeous; hairs 15 mm. long on neck, 11 mm. on back; forearm, 50.2-55.0; interfemoral membrane densely furred over all of its dorsal surface; underside of wing along bones of forearm densely furred; metacarpals graduated from third to fifth, fifth being much the shortest; greatest length of skull, 16.0-18.3; dental formula, i. 1; c. 1; p. 2; m. 3.

The subspecies in Kansas is *Lasiurus cinereus cinereus* named by Beauvois (Catal. Raisonné Mus. Peale, Philadelphia, p. 18, 1796) on the basis of material from Pennsylvania, probably near Philadelphia.

Red Bat

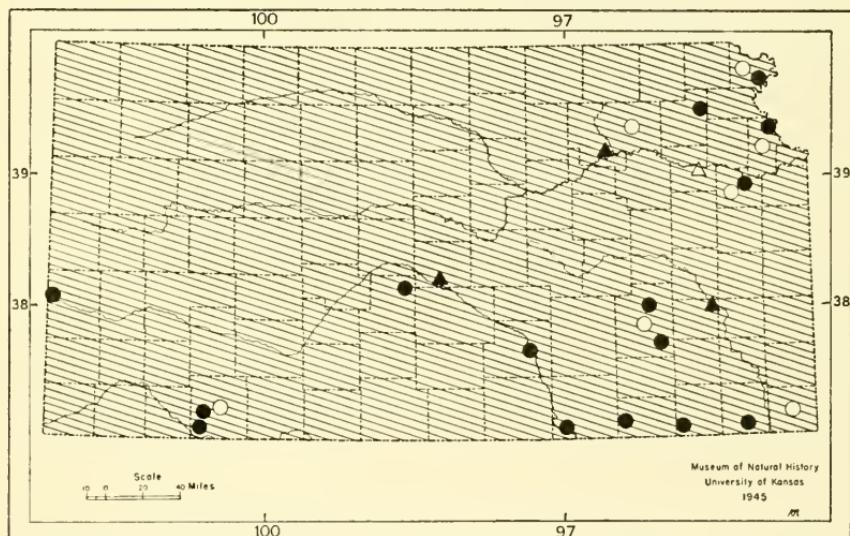
Lasiurus borealis (Muller)

This is a solitary, tree-living, migratory species, which is absent in Kansas in winter. At Lawrence a female has been taken as early as April 26 (they are common by mid-May) but the earliest date for a male (7½ mi. SW Lawrence) was June 18. The males seem not to arrive until about the time that the young are born. Both sexes remain until approximately the end of the third week of September—a female on the 19th and a male on the 20th are the actual dates. The earliest record of young having been born in Douglas County is June 15 and the latest record of finding embryos there is June 20. The number of young varies from 2 to 4, 3 being the usual number.

This number of young is so much larger than in other bats that the first reports of as many as four young per female were thought to be erroneous. Now, however, it is well established that this species has a higher rate of reproduction than nearly all other kinds. Another unusual feature of this species is the difference in color of the sexes; females are a dull buffy chestnut, many of them frosted with white, whereas males are brighter, usually bright orange-red.

When picking ripe peaches a neighbor of mine grasped a female red bat with her three partly grown young clinging to the fur of her underparts. The yellowish color flecked with white caused him to mistake the bats for a peach. When I went to view the mother, with her young compactly tucked to her breast and held in place by the folded tail and attached membrane, the resemblance to one of the ripe peaches was so close that I did not attempt to refute my neighbor's argument that the bat had chosen the peach tree in order to make the most of her protective coloring.

This is the bat most often seen in eastern Kansas because it flies earlier in the evening than other kinds. As many as three or four could sometimes be seen flitting about one of the old style (in 1920) street lights in pursuit of the flying insects that are attracted to such lights, and now (1954) even larger numbers can be seen in the light cast from the carillon tower on the University campus.

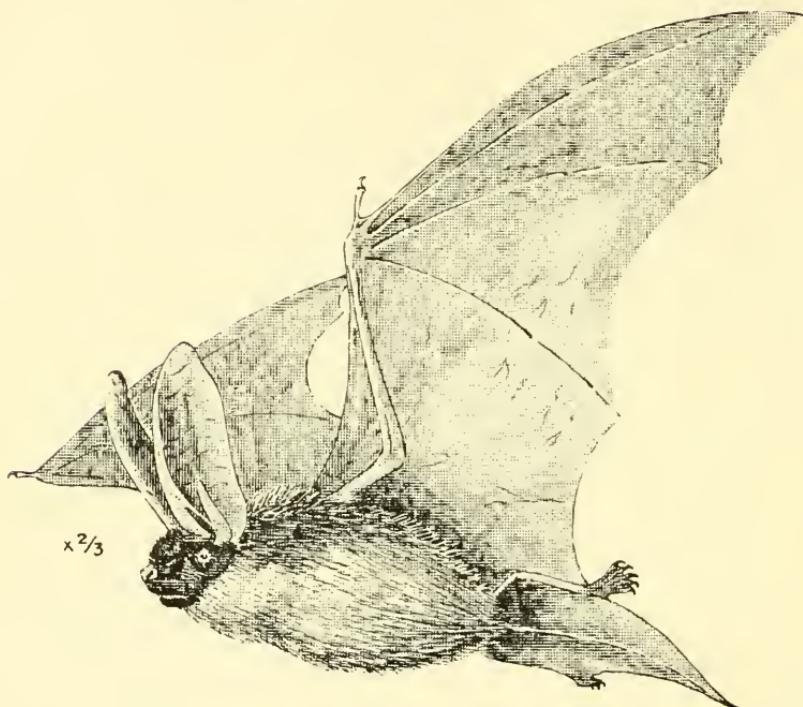


Description.—Total length, 103-124; tail, 47-60; hind foot, 9-10; ear from notch, 12-13. Pelage red, often frosted with white; white tip of hair succeeded by reddish, then light rufous and a basal band of blackish; hairs 10 mm. long on neck and 7 mm. on back; forearm, 38.5-40.6; interfemoral membrane densely furred over all of its dorsal surface; underside of wing with numerous scattered hairs along forearm and patches of fur at bases of 3rd and 5th metacarpal and at base of thumb; metacarpals graduated from third to fifth, fifth being much the shortest; greatest length of skull, 13.5-13.9; dental formula, i. $\frac{1}{3}$; c. $\frac{1}{1}$; p. $\frac{2}{2}$; m. $\frac{3}{3}$.

The subspecies in Kansas is *Lasiurus borealis borealis*, named by Müller (Natursyst. Suppl., p. 20, 1776) from New York.

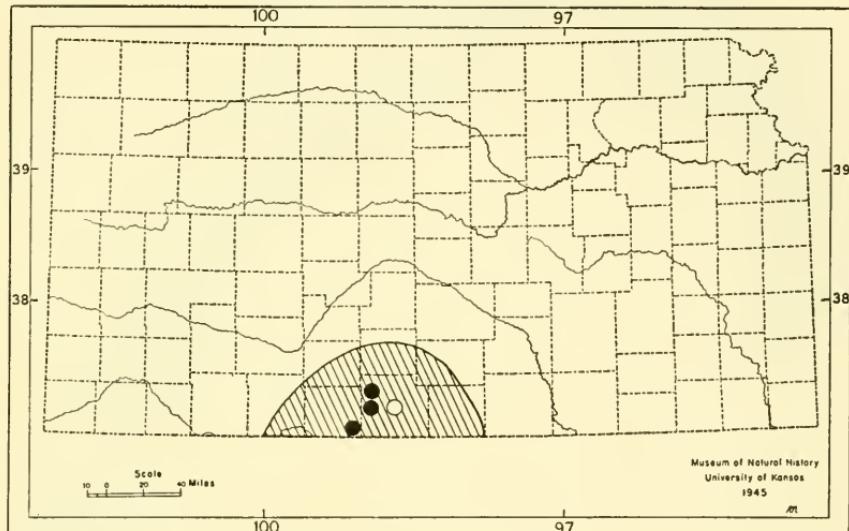
Genus *Corynorhinus* (H. Allen)

Long-eared Bat

Corynorhinus townsendii (Cooper)

This is a cave bat. When the young are being born the females collect in clusters of less than 50—usually approximately 25—individuals. At this time the males live apart and occur singly instead of in clusters. In winter the long-eared bat hibernates in caves where the temperature remains above freezing. Caves that have a temperature as high as 70 degrees Fahrenheit are too warm for purposes of hibernation. Before hibernation begins the bats become fat but when hibernation is finished, so much of this fat has been used up that the animal is more than a fifth lighter than in late autumn. When the bat is at rest the ears, a third as long as the body and tail combined, are folded in a circular fashion. When the resting bats are disturbed the ears are unfolded and extended. When this is done at the same time by all members of a resting cluster the effect holds the observer's attention because of the synchronization of the action; the circles (ears) enlarge, then change into long slender ears, the bats' heads are raised, a score of pairs of

black eyes are directed toward the observer, and the semitransparent ears vibrate in a striking manner before the animals take wing and fly away. At the time I observed this fluttering of the ears I supposed it was caused by a draft of air that certainly moved across the bats. Since then I have wondered if the fluttering was voluntary—a means of catching sounds. The bats that I observed were females and their nearly grown young in a cave in Nevada.



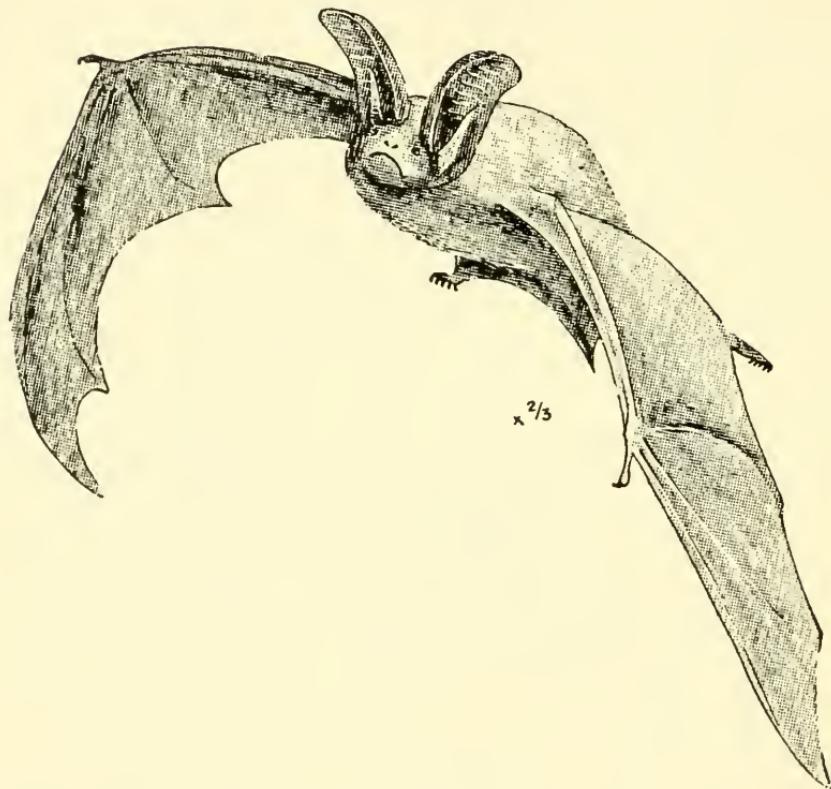
In Kansas the Long-eared Bat has been found only in the area of the gypsum caves in the south-central part of the State. Of the recorded localities, $4\frac{1}{2}$ mi. SW Sun City in Barber County is the northernmost and Swartz Canyon, Comanche County, is the westernmost.

Description.—Total length, 98-104; tail, 40-50; hind foot, 11-14; ear from notch, 29-35; weight, 8-10 grams. Pelage brownish (Natal Brown to Army Brown), slightly lighter below; ears and membranes naked; forearm, 41-44; large glandular swelling on each side of muzzle between eye and nose; skull with interorbital region depressed, rostrum small and its greatest breadth amounting to less than a third of the length of the skull; dental formula, $i.\frac{3}{3}; c.\frac{1}{1}; p.\frac{3}{3}; m.\frac{3}{3}$. From *Antrozous*, this bat can be distinguished by: darker color; narrower ears; shorter forearm (approximately 43 instead of 53 mm.); lump on each side of muzzle; concave, rather than convex, interorbital region of skull; and more teeth (*36 versus 28*).

In Kansas the subspecies is *Corynorhinus townsendii pallescens* named by Miller (N. Amer. Fauna, 13:52, 1897) from Keams Canyon, Navajo County, Arizona. The eastern subspecies, *Corynorhinus rafinesquii ingens* named by Handley (Jour. Washington Acad. Sci., 45:148, 1955) from Hewlitt Cave, 12 mi. W Fayetteville, Washington County, Arkansas, may yet be found in the extreme eastern part of Kansas but at this writing (July 20, 1955) no specimens have been preserved from within the State.

Genus *Antrozous* H. Allen

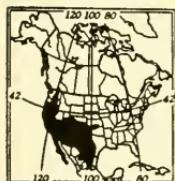
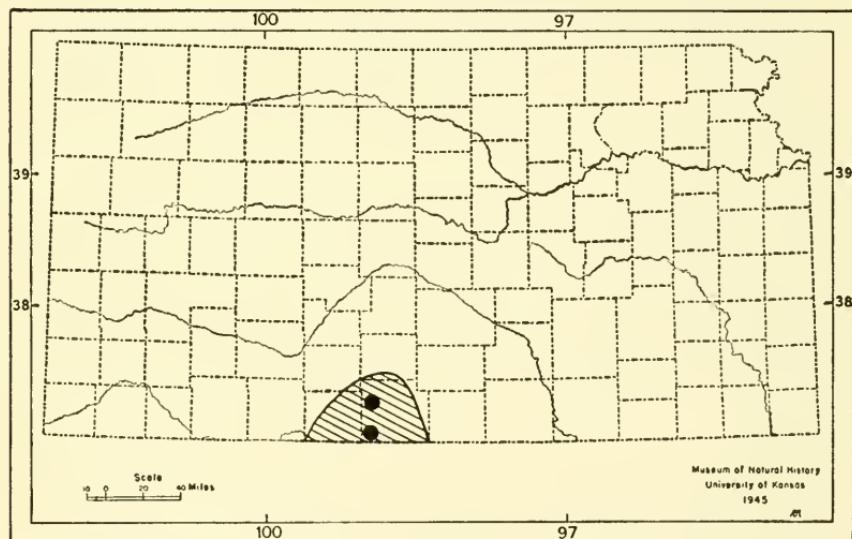
Pallid Bat

Antrozous bunkeri Hibbard

This species is a cave bat. The sexes separate in spring before the young are born. Females containing embryos and females with young are colonial. At that time, spring through summer, adult males live singly. To obtain insects, bats of this species frequently alight on foliage and even on the ground. Pallid Bats, therefore, sometimes are caught in traps that zoologists set on the ground for nocturnal rodents. This species emerges at late dusk.

This trait of emerging at sunset, or shortly thereafter, may be the basis for the Mohammedan legend concerning the creation of the bat by Christ. This legend has it that while keeping the fast of Ramadaham, during which no food may be taken between sunrise and sunset, Jesus retired to a secluded place in the hills where the mountains about Jerusalem shut out from his view the sunset. Therefore, it was impossible for him to ascertain the moment when

the sun sank below the horizon. So, by God's permission, Christ fashioned a clay image of a winged creature, prayed and breathed upon the clay. Thereupon it opened its wings and flew into a cavern. Thereafter it emerged every evening just at the sunset hour and by fluttering about Isa (Jesus) appraised him of the close of day. He then prepared to pray and to partake of food. In spite of this divine origin, the bat seems to have been held in opprobrium by Jewish peoples, for in the apocryphal Book of Baruch the bat is used as a symbol of something abhorrent. Also, it seems that the twentieth verse of the eleventh chapter of Leviticus refers to bats when it states that "all fowls that creep, going upon *all* four, shall be an abomination unto you."



In Kansas the Pallid Bat has been taken at only three localities, all in Barber County, as follows: 7 mi. S Sun City; 5½ mi. S Sun City; and 1 mi. SW Aetna.

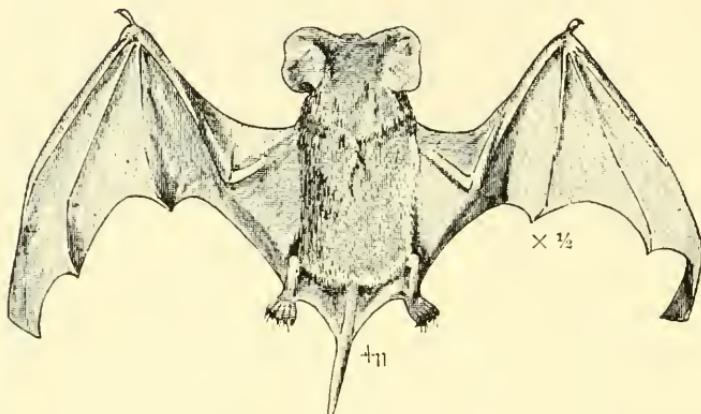
Description.—Total length, 115-130; tail, 40-52; hind foot, 12-15; ear from notch, 26-28; weight, 12-20 grams. Pelage light-yellowish or yellowish brown, lighter beneath; muzzle truncate with low swelling on each side; forearm, 50-54; ears and membranes naked, brownish; metacarpals of third, fourth and fifth fingers of roughly equal length and falling short of elbow when folded back along forearm; skull with distinct sagittal crest which is highest posteriorly; dental formula, i. $\frac{1}{2}$; e. $\frac{1}{1}$; p. $\frac{1}{2}$; m. $\frac{3}{3}$.

Antrozous bunkeri Hibbard (Jour. Mamm., 15:227, 1934) was described as a species on the basis of specimens from seven miles south of Sun City, Barber County, Kansas. It has been suggested, however, that *Antrozous bunkeri* is at most a subspecies of the more western *Antrozous pallidus*.

Family Molossidae

Genus *Tadarida* Rafinesque

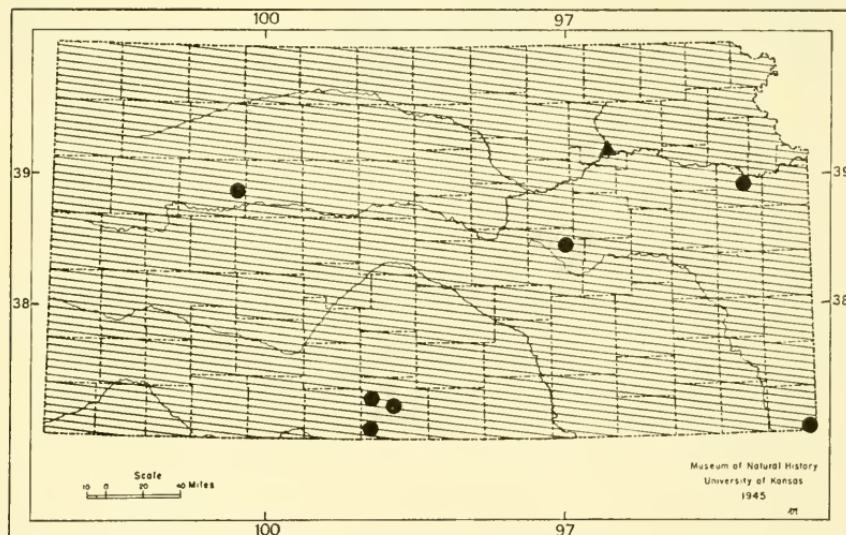
Brazilian Free-tailed Bat

Tadarida brasiliensis (I. Geoffroy)

This it a colonial, non-migratory species. In larger caves the bats of this species occur in numbers estimated in the millions, as for example in the Carlsbad Caverns in New Mexico. Bat guano (manure) accumulates rapidly in such caves. The insect food of bats imparts a high nitrogen content to the guano and it is marketed as fertilizer. In Texas one medical doctor thought that this bat was valuable also because it ate mosquitoes. His idea was that malaria, carried by mosquitoes, could be eliminated in an area where large numbers of this species of bat could be induced to live. Accordingly he built a bat roost on the general plan of the slat-sided structures that are built to house weather recording instruments, but on a scale large enough to allow a truck to be driven below the trap-doors of the bottom of the bat roost. The Brazilian Free-tailed Bats occupied the structure. He recommended that every community plagued with malaria construct one of these roosts. This recommendation proved impractical because this species of bat does not occur in all the areas that, at that time, had cases of malaria. Also, the bats were not attracted to some of the other roosts that were built like the first. Microscopic identification of the remains of insects in the guano from his bat house showed that of the many kinds of insects eaten, mosquitoes were not included. The doctor did, however, make a financial success of his first bat roost, by the sale of guano, and it could be that a careful appraisal of the reason

for success with it would point the way to equally profitable exploitation of the Brazilian Free-tailed Bat in some other places.

Since 1953, when a Red Bat in Florida was found to have rabies, much attention has been given to bats in order to learn if many were infected. The Lesser Free-tailed Bat has been given special attention because some individuals migrate southward in winter into the geographic range of the Vampire Bat, which has long been known to contract rabies. Of course it is well to know the facts and the investigations, therefore, are commendable. It is a reasonable guess, however, that all mammals contract rabies. Finding the disease in bats, therefore, is no occasion for special alarm.



Museum of Natural History
University of Kansas
1945

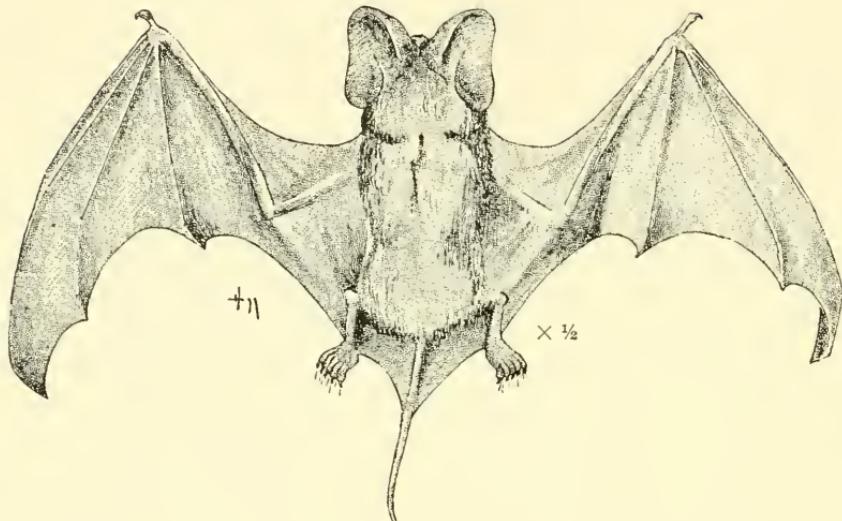


Stragglers of the Brazilian Free-tailed Bat may occur in all parts of Kansas but the species is thought to be regularly resident in only the extreme southern part of the State. After figure 48, showing the record stations of occurrence of this species in Kansas was prepared, a specimen (57136 KU) was obtained for the University of Kansas Museum of Natural History from Elkhart, Morton County, the southwesternmost county in the state.

Description.—Total length, 90-105; tail, 32-40; hind foot, 8-10; ear from notch, 13-19; weight, 8.3-14.4 grams. Pelage blackish brown; hair short and satiny; anterior border of ear with six to eight horny excrescences; tail projecting conspicuously beyond uropatagium; forearm, 41.6-46.6; premaxillary bones separated between upper incisor teeth; greatest length of skull 16.4-17.8.

The subspecies *Tadarida brasiliensis mexicana* was named by Saussure (Rev. et Mag. d. Zool., 12 (ser. 2); 283, July, 1860) on material now thought to have come from approximately 13,000 feet elevation on the Cofre de Perote in the Mexican state of Veracruz, Mexico.

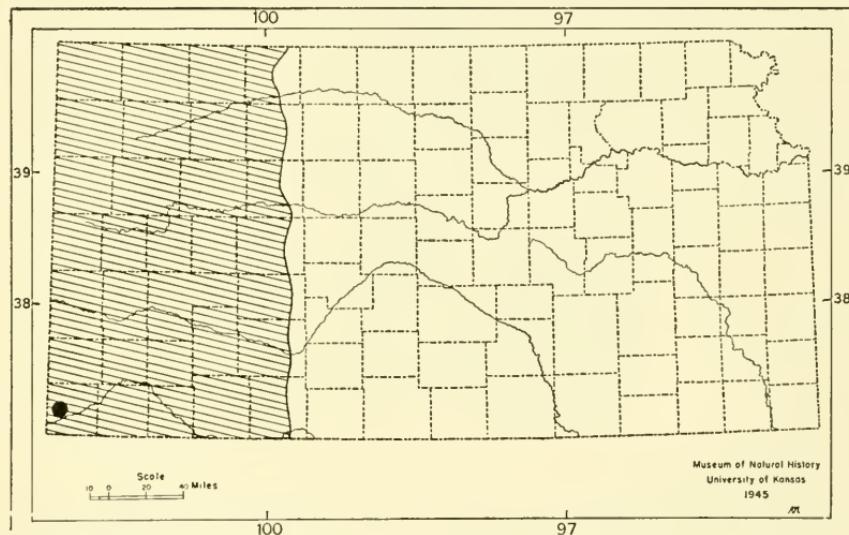
Big Free-tailed Bat
Tadarida molossa (Pallas)



Little is known of the habits of this bat that seems to be rare in the United States. Most of the occurrences north of Mexico have been of only one specimen at a time at any given place. Adrey E. Borell, however, on May 7, 1937, at 6200 feet elevation in the Chisos Mountains of Texas, found approximately 130 individuals, seemingly all females, living in a six-inch wide crack twenty feet long in a cliff (Jour. Mammalogy, 20:65, 1939). The *Tadarida* did not emerge until after dark at 8:20 p. m., which was 40 minutes later than the Western Pipistrelles emerged. This supports the idea that some of our supposedly rare bats, the Big Free-tailed Bat included, are seldom collected because they forage only after it is too dark for persons to see the bats.

In addition to its greater size, *T. molossa* can be distinguished from *T. brasiliensis* by the following features: second phalanx of fourth finger shorter (2.0-4.4 mm. rather than 6.6-9.2 mm.); ears, when laid forward, extending well beyond end of rostrum instead of only to end or short of it; inner edges of ears united at bases for approximately 2 mm. rather than not united; pocket well developed in membrane at angle of femur and tibia, rather than slightly developed or absent; in skull, width of rostrum anteriorly scarcely more, rather than much more, than interorbital constriction; upper incisors parallel rather than converging at tips.

In the preceding account of the Pallid Bat it is stated that some Caucasian peoples look with disfavor on bats. The late Glover M. Allen wrote that some other peoples have less prejudice toward the harmless winged bat. Among the Chinese, who so often see the other side of the shield, bats are held in high regard and by the Buddhists are sometimes considered sacred. In the Chinese language the word for bat is *fu*, which also is the name of the character meaning "happiness", just as with us the word bee has the same sound as the second letter of the alphabet. By substitution, the figure of a bat thus comes to stand for happiness or good luck and is frequently seen worked into designs in different kinds of Chinese handicraft.

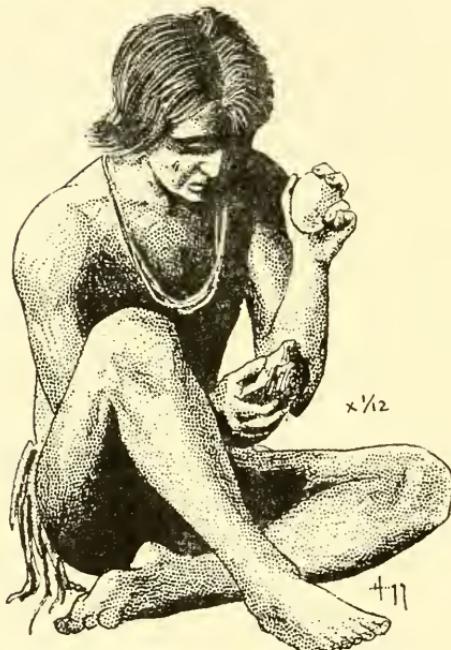


The Big Free-tailed Bat may be state-wide in distribution but probably is of regular (annual) occurrence only in the southwestern part of the State, where it has been taken 9 mi. N Elkhart in Morton County. This species has been recorded from northern South America northeastward to Iowa.

Description.—Total length, 118-138; tail, 48-54; hind foot, 9-13; ear from notch, 26-30. Upper parts light reddish brown to rich dark brown; underparts slightly lighter; hair longer than in *Tadarida brasiliensis*; tail projecting conspicuously beyond uropatagium; forearm, 58.3-63.4; premaxillary bones separated between upper incisor teeth; greatest length of skull, 22.2-24.1.

No subspecies are recognized for this wide-ranging species for which the earliest available name seems to be *Vespertilio molossus* proposed by Pallas (*Miscellanea Zoologica*, p. 49, 1766) on the basis of material from "America," not improbably from Surinam (Dutch Guiana of northern South America).

ORDER PRIMATES
FAMILY HOMINIDAE
Man
Homo sapiens Linnaeus



From prehistoric times until the early part of the nineteenth century only the American Indian occurred in Kansas. Indians mostly lived in villages in the nineteenth century when the Caucasian subspecies invaded the area and annihilated most of the Indians by killing them in direct combat or by spreading disease among them or by depriving the Indians of their lands and the large game mammals. The Caucasians also lived in villages and towns but an equal or larger number lived in family groups, each family apart from the other on its own "farm." In the nineteenth century the Negro, an African subspecies, entered Kansas in company with, but in smaller numbers than, the Caucasian. The Negroes were descendants of the slaves of the southeastern United States, and numbers of the earlier arrivals were themselves born in slavery and some were not freed until the end of the Civil War in 1865. A larger proportion of the Negro subspecies than of the Caucasian subspecies

has lived in towns and cities. The Oriental subspecies, namely the Chinese from 1860 on, and Japanese after 1940, comprise a fourth subspecies, present in only small numbers. So far as known, Orientals in Kansas live exclusively in towns or cities. In all, there were approximately two million persons in the state of Kansas in the year 1955.

Amalgamation of the Indians with the Caucasians has progressed further than has the amalgamation of the Negroes or Orientals with the Caucasians.

In North America the Caucasian subspecies of man much more than any other mammal has altered the environment in an effort to suit his needs. Man, particularly the Caucasian, is notable for constructing houses and larger gathering places such as buildings, for using other mammals and more recently machines (trains, automobiles and aeroplanes) for transportation, for setting up systems of communication (pony express, telephones, telegraph lines, radio, and television) and for controlling the production of his food by domesticating mammals and birds (for example, cattle and geese) and by planting and harvesting grains and fruits.

So much has been written on the habits of man that it would be futile to attempt even to abstract such information in the present booklet. Furthermore, in this age of specialization the most accurate information is to be obtained from the specialist—the Medical Doctor on health and disease, the Minister or other theologian on matters of the spirit and religion, the Horticulturist on food crops, the Sociologist on social affairs, the Archaeologist on extinct cultures, *etc.* Consequently we here do not go beyond the zoological aspect of man except to note, in the two paragraphs, immediately following, a couple of ecological matters that currently are of much concern to Kansans.

One of these matters is the retention of the productive top soil. In cultivated areas so much of it now is being washed away in times of heavy rainfall and so much is blown away in periods of drought that the top soil is being lost faster than it is being formed. This threatens Man's "civilization" and if the loss is allowed to continue it is thought that Man in Kansas will have a lower standard of living and a sparser population than he will if the thickness of the top soil can be preserved or increased; in some parts of the world there are vast areas that were thus abused that once supported thriving populations, now incapable of supporting anybody.

Another matter that limits the size of the population of Man in Kansas (and in all but a small part of the western half of the United States) is the amount of water. This matter has some connection with the first one because retention of the top soil makes for a denser ground-cover of plants; they retard run-off after rains and thus the level of the ground water is raised. Of course fresh water may be diverted from some distant source, say, in the Mississippi River System, or one of the Great Lakes, or water may be

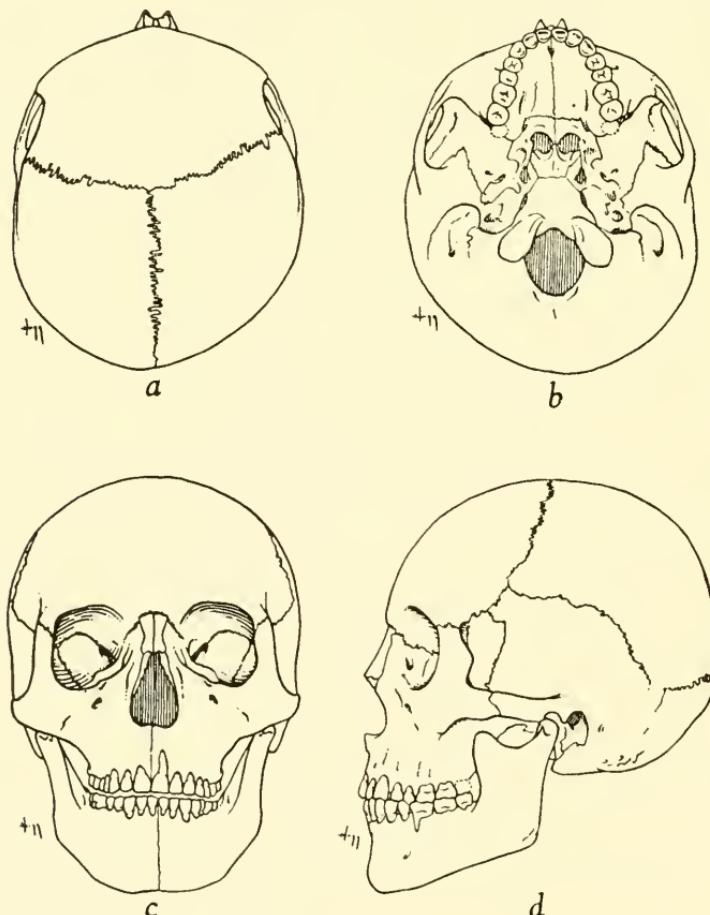


FIG. 8. Skull of Man (American Indian), *Homo sapiens americanus* Linnaeus, Prairie Dog Creek at state line, Phillips Co., Kansas, ♂, No. 14PH4—1436 USNM, after Kivitt, Bull. 154 Bur. Amer. Ethnology, pl. 28, 1953, $\times \frac{1}{4}$.

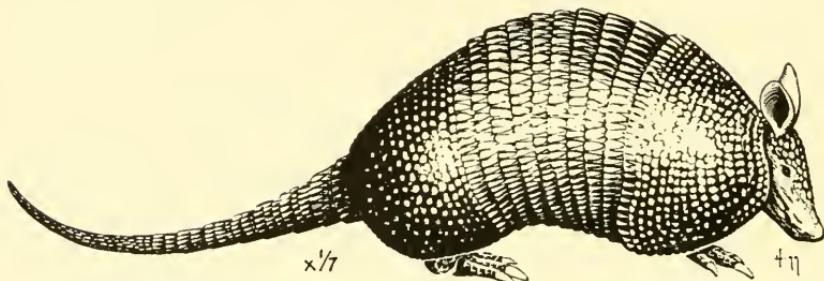
brought from the sea, if and when economical means are found for removing salts. In any event there probably will be less, instead of more, rainfall and snow on the Great Plains in any one of the next two or three centuries than there was in the past century. Nearness to the glaciers of the Arctic makes for more moisture in the Great Plains and distance from these glaciers makes for less rain. These glaciers are growing smaller and their southern edges are retreating farther from the Great Plains. Consequently, to support a given size of population of Man, any system of pipelines or aqueducts should deliver a larger volume of water in the future than when it first functions.

The species is omnivorous and usually eats both animal matter and vegetable matter; actually either alone suffices. After a gestation period of nine months a single offspring is born to females ranging in age from 14 to 49 years. More than one young at a birth is exceptional but as many as five young have been recorded. At birth the average young weighs approximately $7\frac{1}{2}$ lbs. or one-seventeenth as much as the adult female. The newborn young has the eyes open but is helpless and nurses for nine months or even longer. The young remain with the parents until 12 to 21 years of age becoming full grown in the 14th to 19th year. The male shares with the female the task of providing food for the young.

Description.—Males, total height, $5\frac{1}{2}$ to $6\frac{1}{2}$ feet; length of (hind) foot, 6 to 13 inches; ear from notch, $1\frac{1}{4}$ to $2\frac{3}{4}$ inches; weight, 135 to 230 lbs. Color, depending on subspecies, pinkish white to black; hair sparse, principally on top of head, face (of males), axillary and inguinal areas; mammae one pair pectoral. Females average 20 per cent lighter in weight than males. Dental formula: i. $\frac{3}{2}$; c. $\frac{1}{1}$; p. $\frac{3}{2}$; m. $\frac{3}{3}$ = 32 teeth.

The species occurs in all parts of the State. Four subspecies now are in Kansas. In order of decreasing abundance they are as follows: *Homo sapiens sapiens* Linnaeus (*Systema Naturae*, ed. 10, 1:20, 1758), the Caucasian (White Man), with type locality at Upsala, Sweden, is non-native, arrived by voluntary invasion as pioneers, increased amazingly from 1865 to 1895 both by breeding and by immigration; still increasing by breeding but part of the increase emigrates; Caucasians in Kansas are descendants of Europeans and peoples from western Asia—English, German, Irish, Swede, Italian, Russian, Pole, etc. *Homo sapiens afer* Linnaeus (*ibid.*, p. 22), the Negro, also is non-native and was forcibly introduced by Caucasians into eastern North America and a few were thus introduced into Kansas although many later spread westward voluntarily from states to the east; type locality in Africa. *Homo sapiens americanus* Linnaeus (*ibid.*, p. 20), the American Indian, is the native subspecies with type locality in North America. *Homo sapiens asiaticus* Linnaeus (*ibid.*, p. 21), the Oriental, also is non-native, arrived by voluntary invasion, but later than the Caucasian and Negro; the type locality is in Asia.

ORDER EDENTATA
FAMILY DASYPODIDAE
Genus *Dasypus* Linnaeus
Nine-banded Armadillo
Dasypus novemcinctus Linnaeus



A notable feature of the Armadillo is that identical quadruplets are the rule. The food is 93 per cent animal matter and nearly all of this is insects and other invertebrates. Many of these are kinds injurious to agriculture. The white meat has a delicate flavor and the Armadillo is much prized by man for food. Burrows are dug in search of food and as places in which to live; these burrows are the homes and refuge sites for many other kinds of animals. It seems that the Armadillo is a desirable animal from man's point of view. The bony skin causes the Armadillo to be heavier than most other kinds of mammals of the same size; to increase its buoyancy when swimming the Armadillo ingests air into the digestive tract. A nervous response of the Armadillo to danger is to jump upward and this works to its disadvantage with automobiles; they strike and kill many Armadillos that otherwise might be passed over unhurt. "The Armadillo: in relation to agriculture and game" is the title of an informative 61-page booklet written by Mr. E. R. Kalmbach and published in 1943 by the Game, Fish and Oyster Commission of Austin, Texas.

Description.—Total length, 615-800; tail, 245-370; hind foot, 75-107; ear from notch, 40; weight, 8 to 17 lbs. (♀ , 8-13; ♂ , 12-17); greatest length of skull, 85.5-100. Four toes on forefoot and five on hind foot; a claw on each digit; top of head, all of tail, and sides and back covered with horny scales that form a turtlelike carapace on the body; scapular shield and pelvic shield each of 18-20 rows of ossified scutes; 8-11 (usually 8 or 9) movable rows of scutes on part of body between forelegs and hind legs.

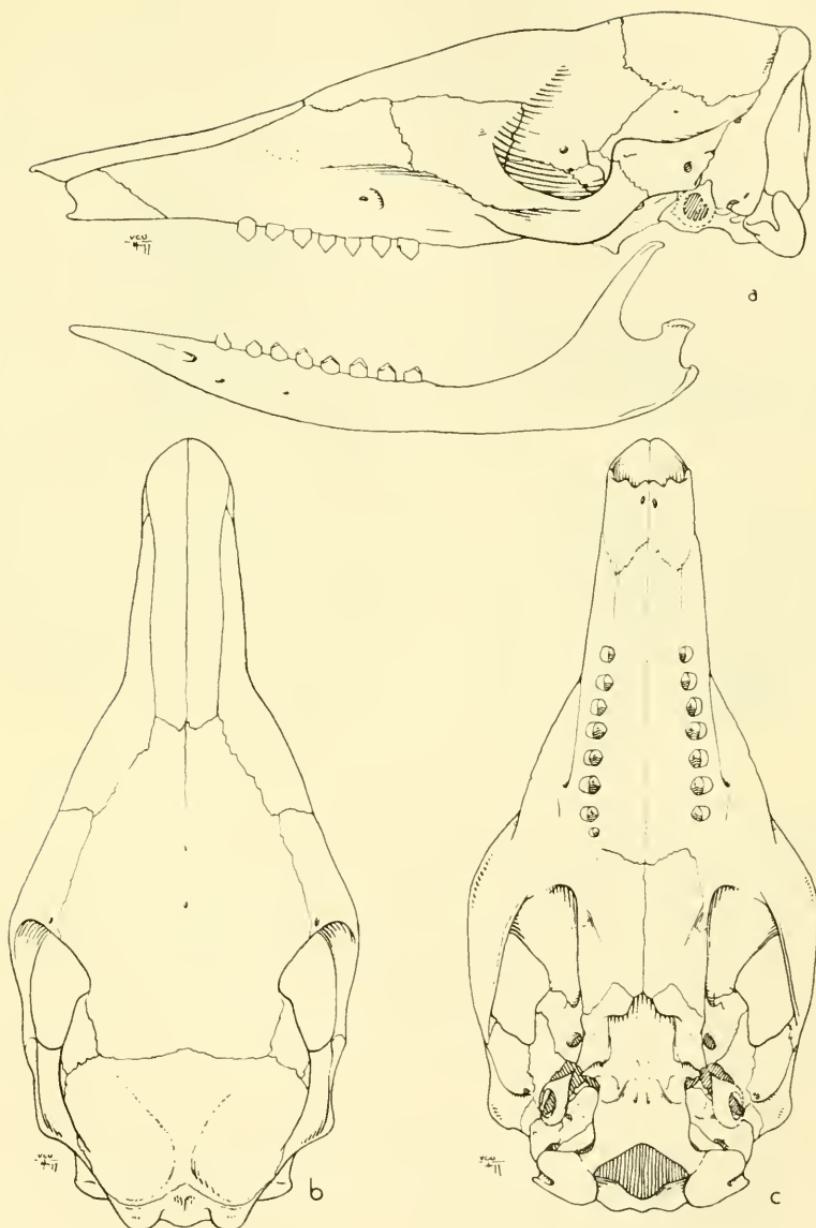
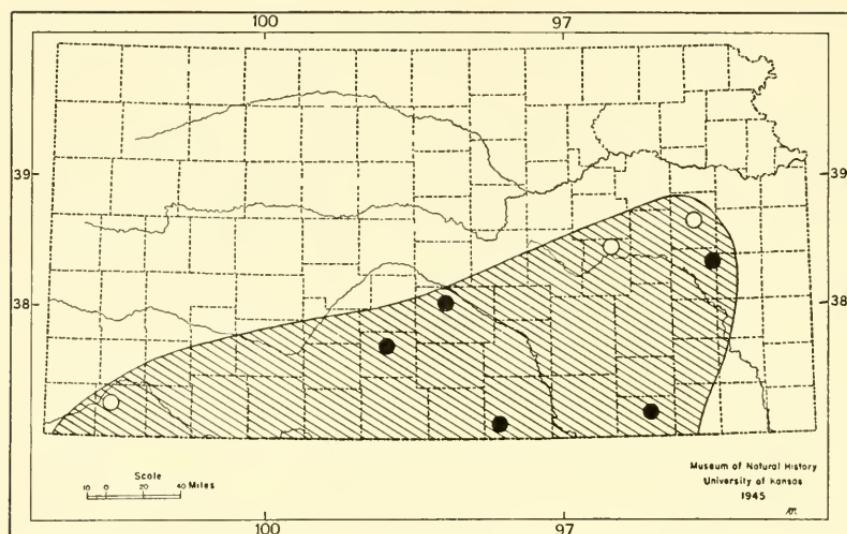


FIG. 9. Skull of Nine-banded Armadillo, *Dasypus novemcinctus mexicanus*. Peters, 20 km. ENE Jesús Carranza, 200 ft., Veracruz, Mexico, ♂, No. 32118 KU, $\times 1$.

In Kansas there is only the one subspecies, *Dasypus novemcinctus mexicanus* Peters (Monatsber. k. preuss. Akad. Wissenschaft., Berlin, p. 180, 1864), with type locality at Matamoros, in the state of Tamaulipas, Republic of Mexico.



In Kansas the range as now known is the southern part of the State east and north to Osage County, but the animal seems to be pushing northward. Occurrences (see fig. 54) not heretofore recorded are: 1 mi. N and 4½ mi. W Harris in Coffey County by William Bradley on May 18, 1953; 5½ mi. N and 1¾ mi. W Abbyville (specimen No. 14410 KU).

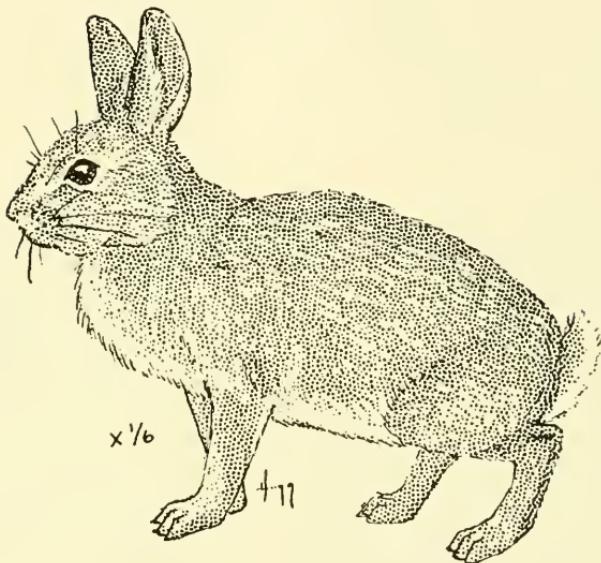
ORDER LAGOMORPHA—KEY

1. Hind foot more than 105 mm.; ear more than 90 from notch; interparietal fused with parietals.
2. Top of tail all white or with dusky or buffy mid-dorsal stripe which does not extend onto back; hind foot more than 138; occlusal face of upper incisor having a complex infolding of enamel from anterior face of tooth White-tailed Jack Rabbit, page 70
- 2'. Top of tail black and black extending onto back; hind foot less than 138; occlusal face of upper incisor having a simple infolding of enamel from anterior face of tooth Black-tailed Jack Rabbit, page 74
- 1'. Hind foot less than 105 mm.; ear less than 90 from notch; interparietal not fused with parietals.
3. Total length more than 470; basilar length of skull more than 60; ½ or all of postorbital projection of supraorbital process fused to skull leaving no aperture or only a small one Swamp Rabbit, page 68
- 3'. Total length less than 470; basilar length of skull less than 60; less than ½ of postorbital projection of supraorbital process fused to skull and leaving an aperture.
4. Length of ear usually more than 60; diameter of auditory meatus more than 37 per cent of alveolar length of row of upper cheek-teeth Desert Cottontail, page 66
- 4'. Length of ear usually less than 60; diameter of auditory meatus less than 37 per cent of alveolar length of row of upper cheek-teeth Eastern Cottontail, page 61

FAMILY LEPORIDAE

Genus *Sylvilagus* Gray

Eastern Cottontail

Sylvilagus floridanus (J. A. Allen)

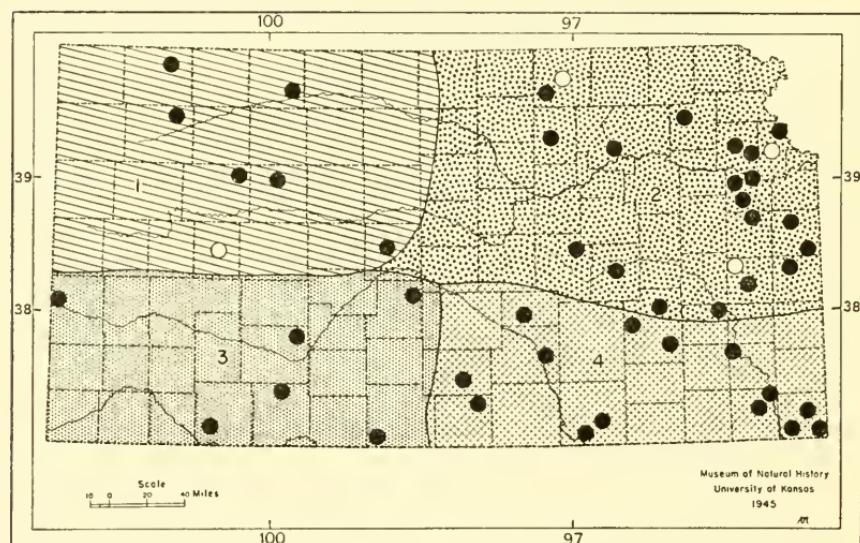
The distribution is state-wide but in the western third of the State this species lives more in the taller plant cover such as is found along stream courses and another species, the Desert Cottontail, is commoner on the upland where plant cover is shorter.

Cottontails are the most popular game mammals in the State. The rabbits and hares are the only species of game in Kansas that still are hunted commercially and that are sold for food on the open market.

Eastern Cottontails are more active in the evening than in the day and are more or less active also at night. In the day they rest in "forms" in the grass and some live in underground burrows dug by other animals, and in hollow logs or brush piles. The young are born after a gestation period of twenty-six and a half to thirty days, in a nest dug a few inches into the ground and lined with dried plant fibers and fur plucked from the coat of the mother. There is more than one litter per year of two to seven young; four or five are the common numbers found in litters. A great variety of plants is eaten and in winter when green food is scarce or un-

obtainable the cottontails eat the bark and woody stems of sprouts and small saplings. Young fruit trees can be killed by the cottontails. Smearing the trunks with one or another deterrent that smells, or tastes, bad to the rabbits is effective in some instances but in many instances fails as sometimes also does tarred paper or other fiber wrappings. A sleeve two feet high of wire mesh large enough to leave an inch or so of space between the wire and the trunk is the surest and eventually cheapest means of protection.

A half day's rabbit-hunt following a light snowfall can be good medicine for the ills of a sedentary person and should yield a dozen or so cottontails for the home freezer.



Distribution of *Sylvilagus floridanus*. 1. *S. f. similis*.
2. *S. f. mearnsii*. 3. *S. f. llanensis*. 4. *S. f. alacer*.

Description.—Total length, 374-460; tail, 39-75; hind foot, 85-108; ear from notch, 51-65; weight 1½ to 3½ lbs. Pelage long and dense, brownish on upper parts and white on underparts including underside of tail; skull with transversely thick posterior extension of supraorbital process of frontal; dental formula, i. 2; c. 0; p. 3; m. 3, as in all Kansas rabbits and hares (jack rabbits).

Four subspecies occur in Kansas: *Sylvilagus floridanus similis* Nelson (Proc. Biol. Soc. Washington, 20:82, July 22, 1907—type from Valentine, Cherry County, Nebraska) in the northwest, *S. f. mearnsii* (J. A. Allen, Bull. Amer. Mus. Nat. Hist., 6:171, May 31, 1894—type from Fort Snelling, Hennepin County, Minnesota) in the northeast, *S. f. llanensis* Blair (Occas. Papers, Mus. Zool., Univ. Michigan, 380:1, June 21, 1938—type from Old "F" Ranch Headquarters, Quitaque, Brisco County, Texas) in the southwest and *S. f. alacer* (Bangs, Proc. Biol. Soc. Washington, 10:136, December 28, 1896—type from Stilwell, Boston Mountains, Adair County, Oklahoma) in the southeast.

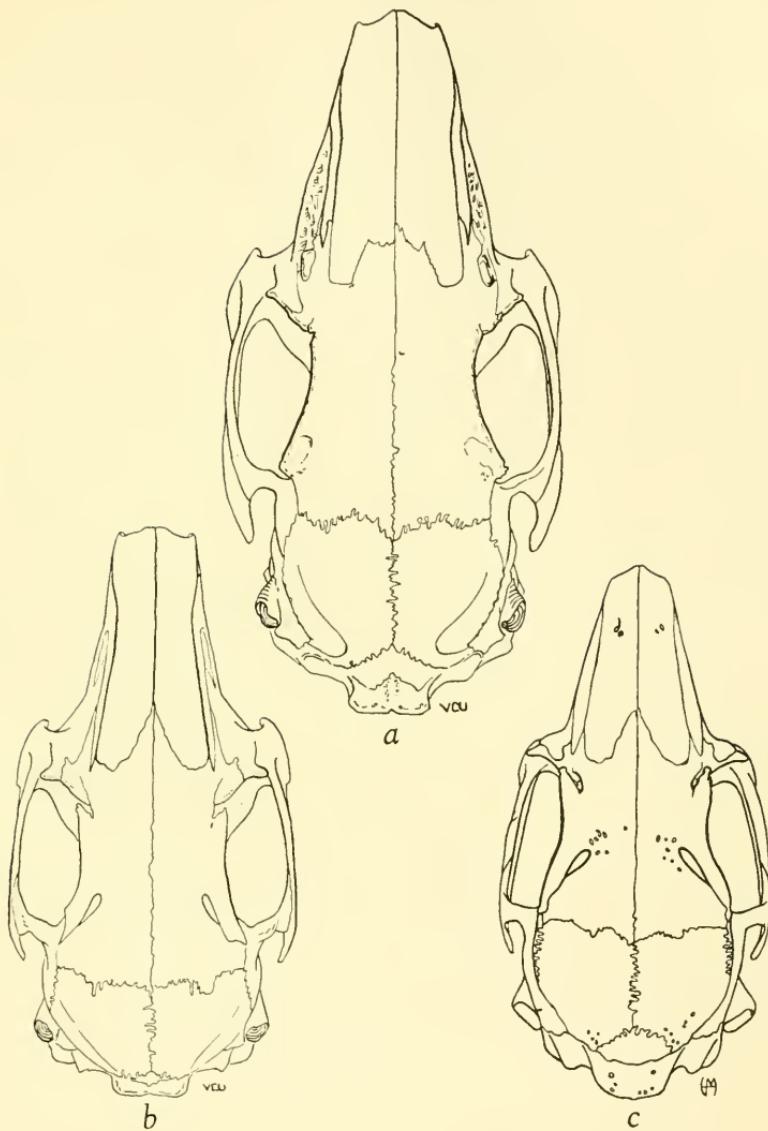


FIG. 10. Dorsal (top) views of skulls of three rabbits. All natural size.

- a. Swamp Rabbit, *Sylvilagus aquaticus aquaticus*, Bachman, Crawford Co., Kansas, ♂, No. 8544 KU.
- b. Eastern Cottontail, *Sylvilagus floridanus mearnsii* (J. A. Allen), 4 mi. NW Lawrence, Douglas Co., Kansas, ♂, No. 3774 KU.
- c. Desert Cottontail, *Sylvilagus audubonii* [subspecies *arizonae* (J. A. Allen)], 3½ mi. Eagle Valley, 5800 ft., Lincoln Co., Nevada, ♂, No. 48960 MVZ.

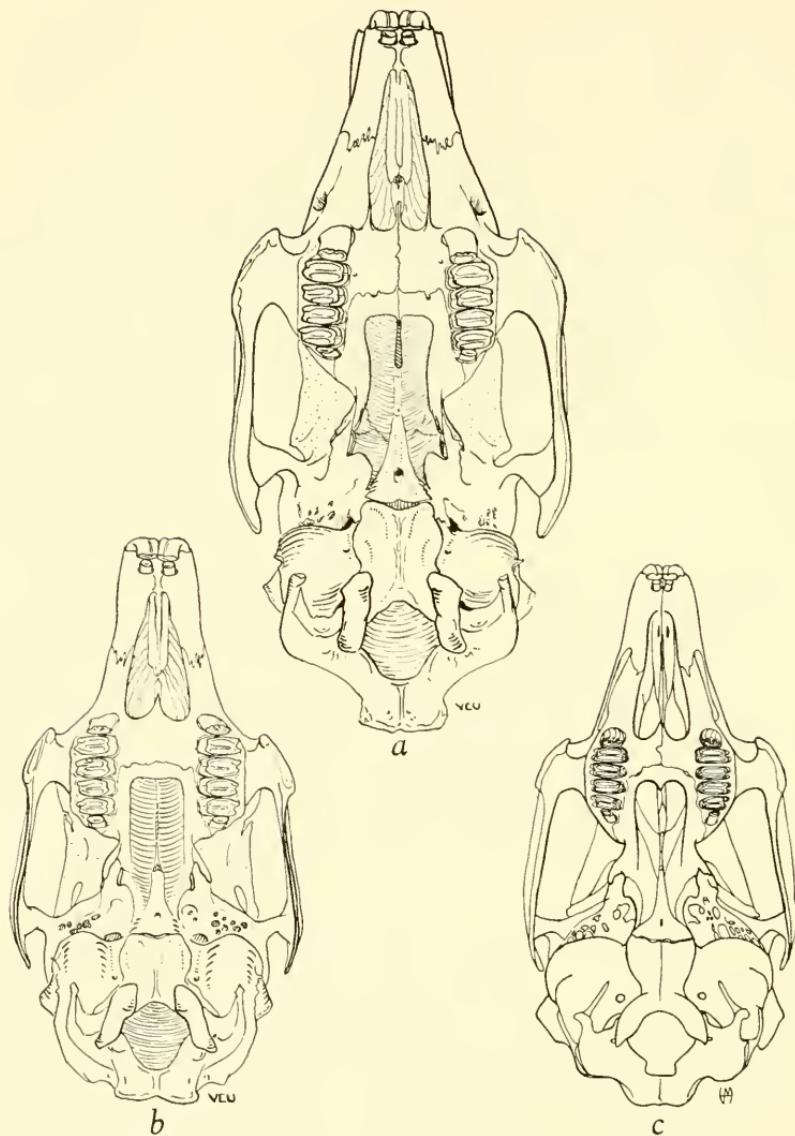


FIG. 11. Ventral (bottom) views of skulls of three rabbits. All natural size. Other views of these same skulls are shown in figs. 10 and 12.

- a. Swamp Rabbit, *Sylvilagus aquaticus*.
- b. Eastern Cottontail, *Sylvilagus floridanus*.
- c. Desert Cottontail, *Sylvilagus audubonii*.

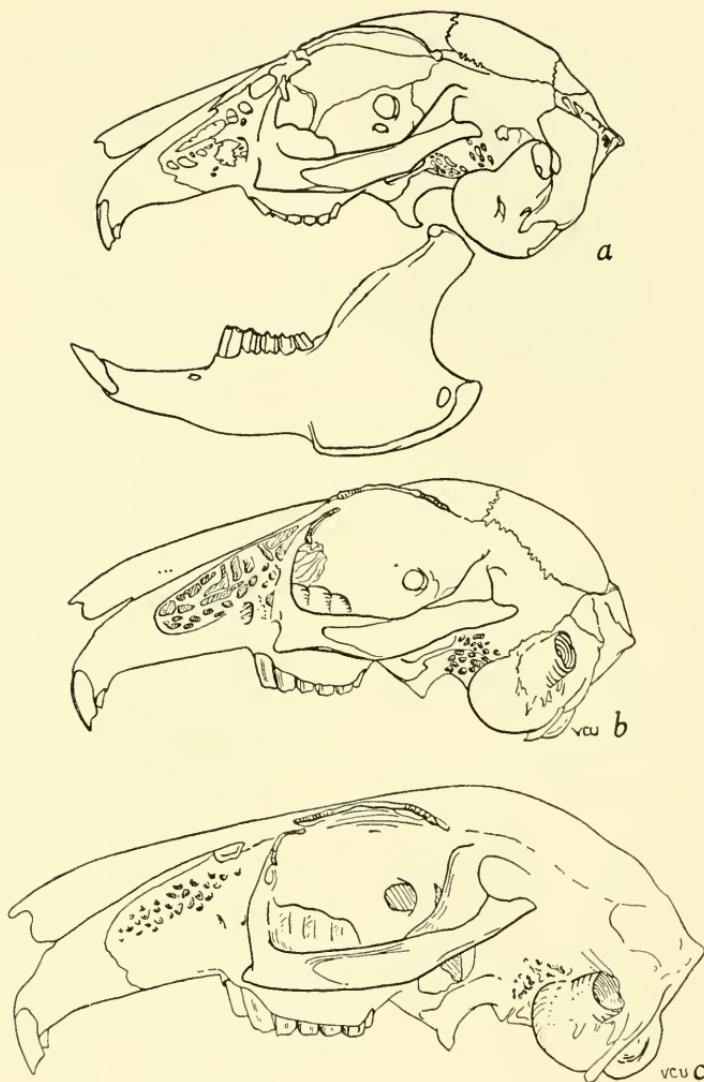
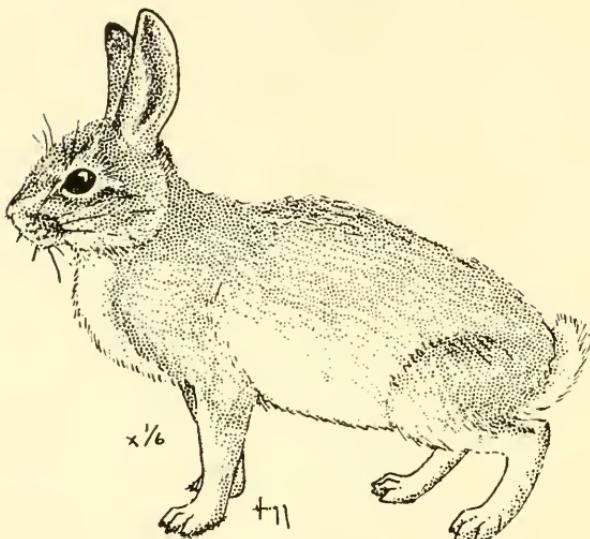


FIG. 12. Lateral (side) views of skulls, one with lower jaw, of three rabbits. All natural size. Other views of these same skulls are shown in figs. 10 and 11.

- a. Desert Cottontail, *Sylvilagus audubonii*.
- b. Eastern Cottontail, *Sylvilagus floridanus*.
- c. Swamp Rabbit, *Sylvilagus aquaticus*.

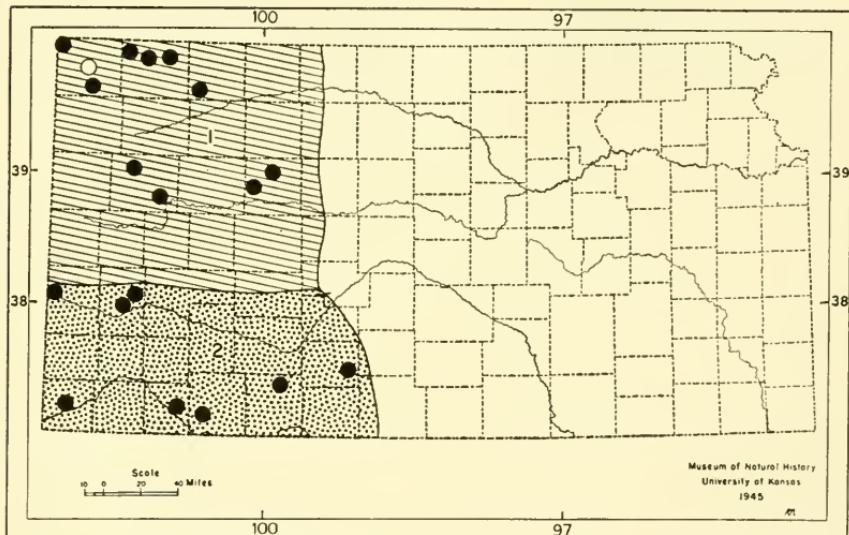
Desert Cottontail

Sylvilagus audubonii (Baird)

The Desert Cottontail seems to have fewer young per litter than does the Eastern Cottontail. The cottontails (*S. audubonii* and *S. floridanus*) and the swamp rabbit (*S. aquaticus*) differ from the hares in that the young are born blind, hairless, unable to run, and in a fur-lined nest. The hares, on the contrary, are born with the eyes open, are fully furred, and they are able to run about within a few hours. The hares are not born in a nest. The skulls of adults of the two groups differ: in the cottontails (Genus *Sylvilagus*) the interparietal bone is separate from (not fused to) the parietal bones whereas in the hares (jack rabbits, Genus *Lepus*) the interparietal bone is fused with the parietal bones. Although in Kansas the hares are the larger, this is not everywhere true.

Correlation of structure and function is well illustrated among our lagomorphs by the means which the different species employ to detect, and escape from, their enemies. A gradient series is evident in our species. The Black-tailed Jack Rabbit, for example, in relation to size of the entire animal, has the longest ears and longest hind legs. It takes alarm when an enemy, for example, a coyote, is yet a long way off. The jack rabbit seeks safety in running; even when being overtaken by a pursuer that is close behind, the jack rabbit still relies on its running ability instead of entering thick brush or a hole in the ground where its larger pursuer would be unable to fol-

low. The Desert Cottontail has shorter ears and shorter hind legs. It often allows the enemy to approach more closely than the jack rabbit does before running, and then, although relying in considerable measure on its running ability for escape, flees to a burrow or thicket for safety from its pursuer. The Eastern Cottontail has shorter ears and shorter hind legs than does the Desert Cottontail and seldom if ever ventures so far away from the edge of dense cover as does the Desert Cottontail. After an enemy has closely approached it, an Eastern Cottontail has merely to scamper back into the brush or other safety retreat.



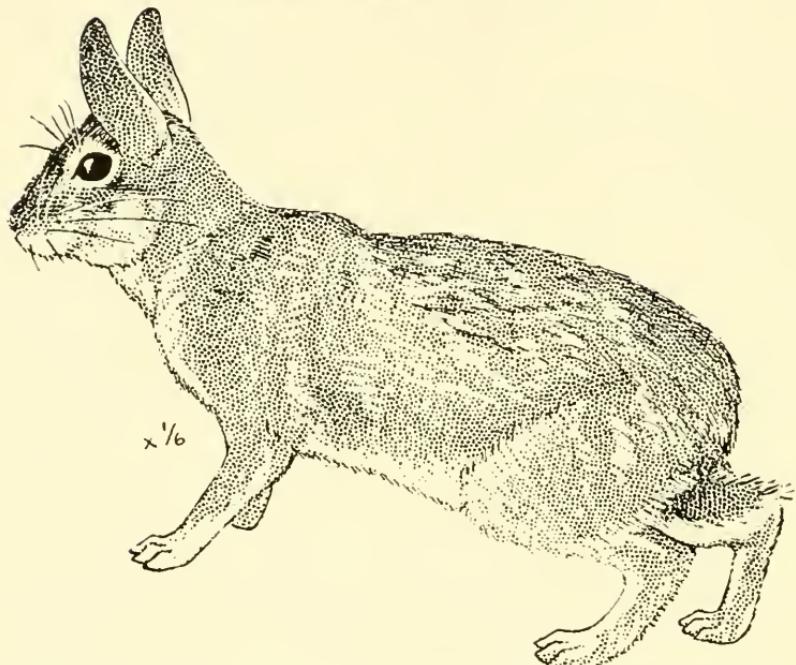
Distribution of *Sylvilagus audubonii*.
1. *S. a. baileyi*. 2. *S. a. neomexicanus*.

The easternmost record stations of occurrence are Wa-keeney in Trego County and the Rezeau Ranch 5 mi. N Belvidere in Kiowa County.

Description.—Total length, 350-401; tail, 44-61; hind foot, 82-93; ear from notch, 59-69; weight (Wyoming specimens), ♂ 2 lbs. 5 oz. (1060 grams), ♀ 3 lbs. (1327 grams). Pelage indistinguishable from that of *S. floridanus*; ears and hind legs averaging relatively longer than in *S. floridanus*; also, in the skull the auditory bulla and external auditory meatus are larger.

Two subspecies occur in Kansas: *Sylvilagus audubonii baileyi* (Merriam, Proc. Biol. Soc. Washington, 11:148, June 9, 1897—type from Spring Creek, east side of Bighorn Basin, Bighorn County, Wyoming); and *S. audubonii neomexicanus* Nelson (Proc. Biol. Soc. Washington, 20:83, July 22, 1907—type from Fort Sumner, De Baca County, New Mexico).

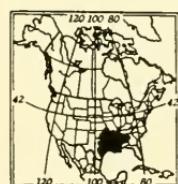
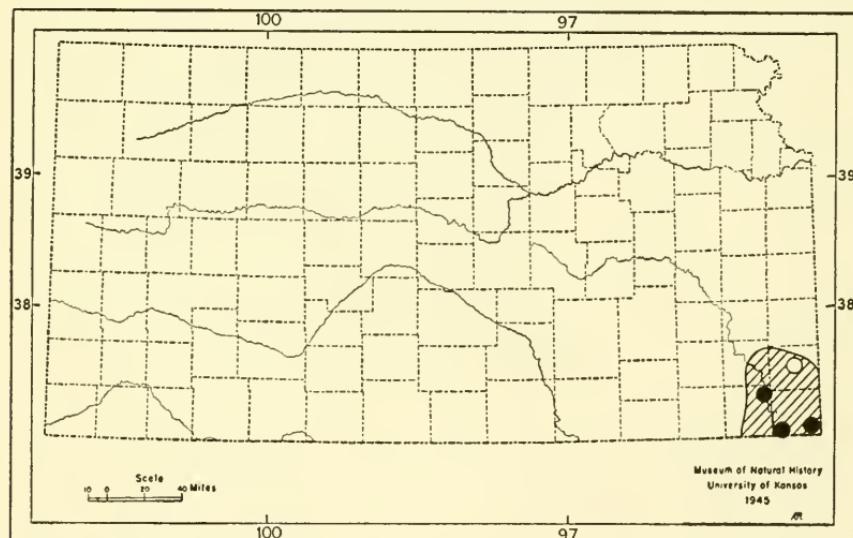
Swamp Rabbit

Sylvilagus aquaticus (Bachman)

The Swamp Rabbit occurs in Kansas only in the southeastern part of the State in Cherokee, Labette (10 mi. E and 1½ mi. N Parsons) and Crawford (no precise locality given) counties. In this area the species lives in the wet bottomlands along the Neosho River and its tributaries. The Swamp Rabbit differs from the Eastern Cottontail, which occurs in the same part of the State, in larger size, shorter and sleeker fur, and more thinly haired tail. In this species, as in all of the rabbits and hares, the female seems to average larger than do the males. This is the reverse of the condition in all other kinds of mammals of Kansas. In other areas this species has been thought to have two litters a year, each of one to six young.

This big rabbit—bigger than either of our two cottontails but smaller than either of our two jack rabbits—may stay in, and close to, brushy cover even more than does the Eastern Cottontail. I have never hunted Swamp Rabbits and have never eaten one, but understand that persons living in southeastern Kansas much prefer the Swamp Rabbit to the Eastern Cottontail because the flesh is equally tender and the Swamp Rabbit is the larger.

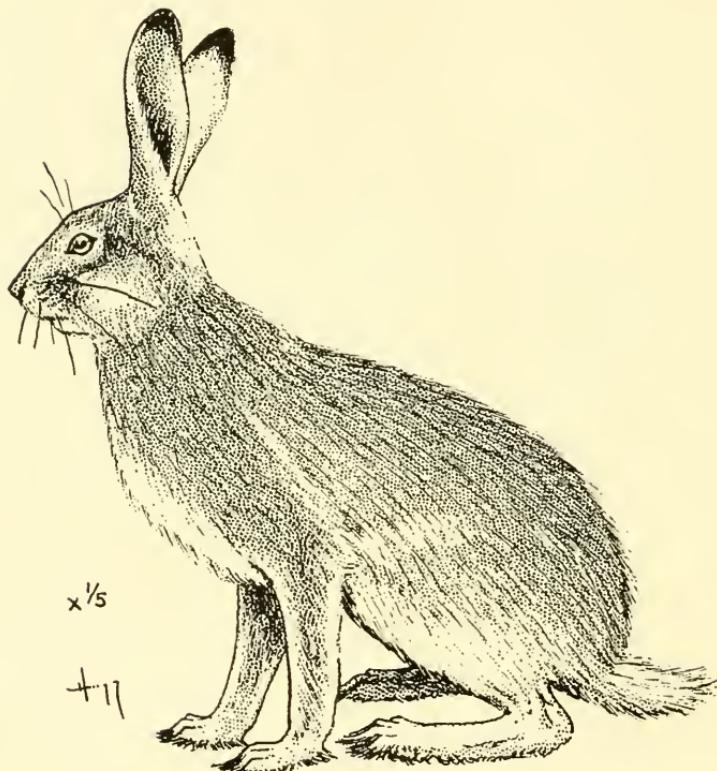
The delectable flesh of the genus *Sylvilagus*, the large numbers that occur on a small area, even in thickly settled rural areas, and the wariness that rabbits develop when much hunted, give them top ranking among small game mammals. Tens of thousands of cottontails in Kansas and Missouri (but rarely the Swamp Rabbit, I am told) are captured alive, transported to the eastern United States and released there to bolster the local supply of game. Considering that certain ectoparasites are limited to certain hosts and that some ectoparasites transmit such diseases as Rocky Mountain Spotted Fever whereas other ectoparasites do not, this transplantation of rabbits is dangerous. Also, expending a hundred dollars on improving the habitat for cottontails in a given area in the eastern United States would produce far more cottontails than would the same sum if expended for live animals, from the Middlewest, that are to be released in the new habitat there in the East.



Description.—Total length, 490-540; tail, 67-71; hind foot, 105-110; ear from notch, 71-75. Upper parts blackish brown or reddish brown; underparts with some white; under side of tail white; posterior extensions of supraorbital processes joined for their entire length with side of braincase or, in some specimens, with a small foramen between the braincase and the base of the posterior extension of the supraorbital process of the frontal bone.

Only the one subspecies, *Sylvilagus aquaticus aquaticus*, occurs in Kansas and it was named by Bachman (Jour. Acad. Nat. Sci. Philadelphia, 7:319, 1837) with the type locality in the western part of Alabama.

Genus *Lepus* Linnaeus
White-tailed Jack Rabbit
Lepus townsendii Bachman



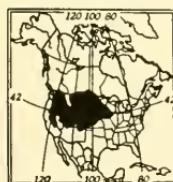
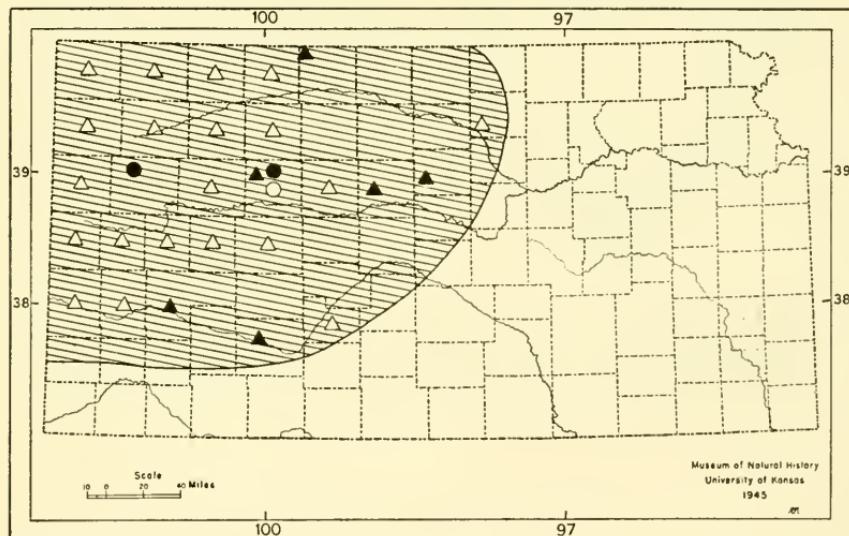
As the prairie was broken up and crops were planted on the land the White-tailed Jack Rabbit retreated to the north and west. Originally this species was shot for its fur which was used in making felt. There are said to be three to six young, usually four.

This jack rabbit ranged over the western half of the State, excepting the southern tier of counties but now is extinct in Kansas or occurs only rarely in the northwestern counties. Sixty miles northwest of Fort Riley and Edwards County (exact locality unspecified) are the two record stations of occurrence on the southeastern side of the range as shown on the accompanying distribution map.

Vernacular names are misleading because the name jack rabbit is applied to a hare and the name Belgian Hare is applied to a rabbit. Belgian 'hares' are commonly bred in captivity. There are many do-

mestic strains and varieties—all are descended from the European Rabbit—and the animals are second only to poultry in some areas as a source of protein food for man. Also, the pelts are sold as a source of felt and many of the skins are dyed and processed for making fur coats and other fur-pieces that appear on the market under names not readily associated with rabbit.

The introduction of the European Hare into the eastern part of the American Continent in late years has been successful in the sense that the animal is multiplying. If it continues to increase and spread the increase almost certainly will be at the expense of some native species of hare or rabbit. This circumstance and the unfortunate consequences of the introduction of the European Rabbit into New Zealand and Australia give us adequate reason to exterminate the alien European Hare before it spreads more widely and replaces some more desirable species, say, the White-tailed Jack Rabbit.



Description.—Total length, 565-655; tail, 66-112; hind foot, 145-172; ear from notch, 104-121; weight (of 2, Nevada and Idaho) 5 lbs. (2494 grams) and 6½ lbs. (2945 grams). Upper parts grayish brown, tail all white or with a dusky or buffy mid-dorsal stripe which does not extend onto back; white in winter in northern part of its range, as for example in North Dakota; occlusal (chewing) surface of first upper incisor revealing a complex infolding of enamel from anterior face of tooth.

Only the one subspecies, *Lepus townsendii campanius* Hollister (Proc. Biol. Soc. Washington, 28:70, March 12, 1915), occurred in Kansas. The type locality is on the plains of Saskatchewan, probably near Carlton House.

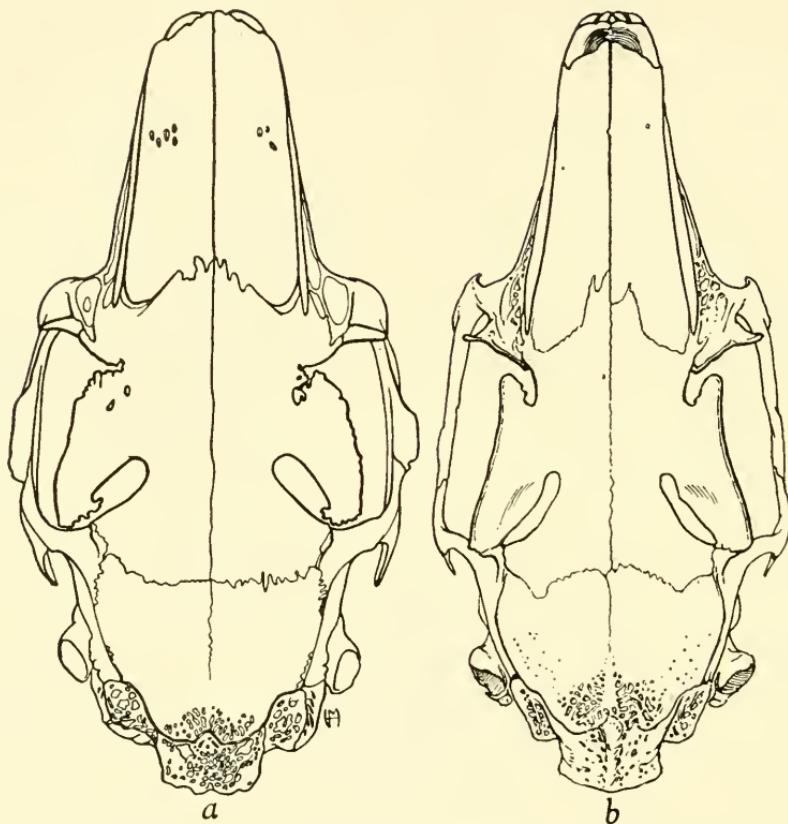


FIG. 13. Dorsal (top) views of skulls of two jack rabbits, natural size.
Other views of these same skulls are shown in figs. 14 and 15.

- a. White-tailed Jack Rabbit, *Lepus townsendii*.
b. Black-tailed Jack Rabbit, *Lepus californicus*.

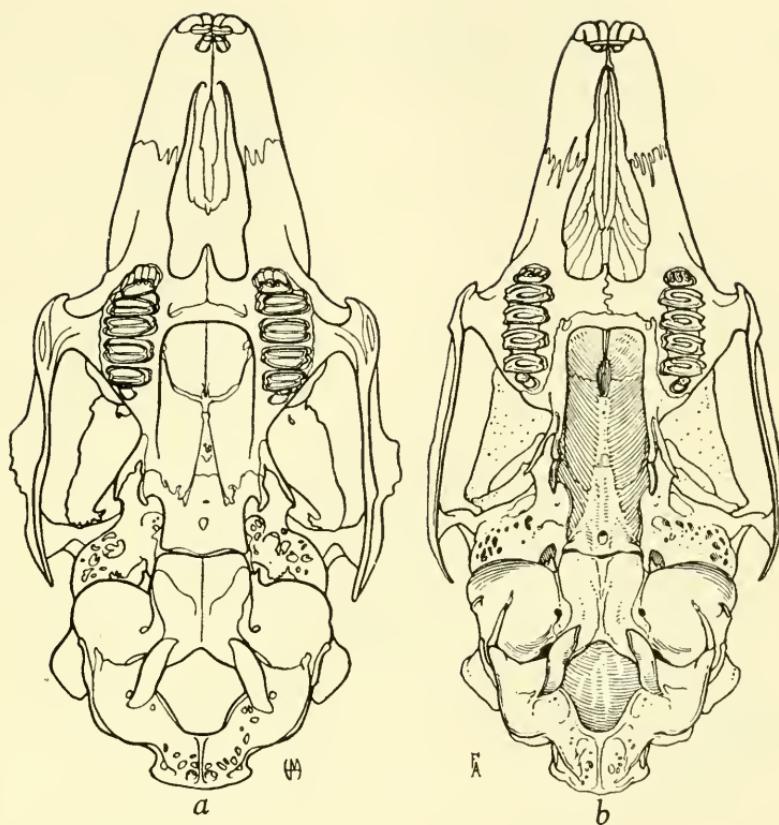
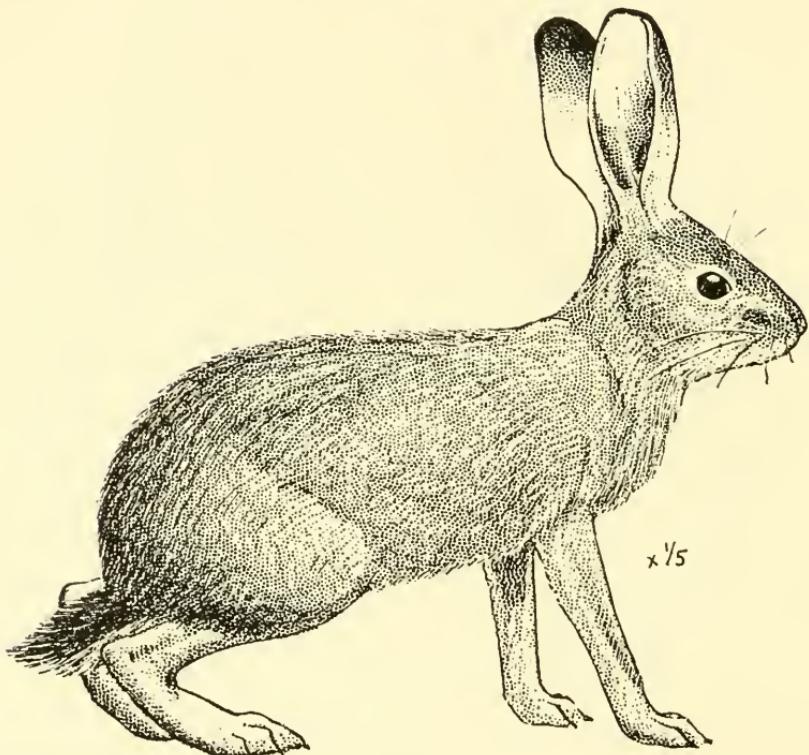


FIG. 14. Ventral (bottom) views of skulls of two jack rabbits, natural size. Other views of these same skulls are shown in figs. 13 and 15.

- a. White-tailed Jack Rabbit, *Lepus townsendii*.
- b. Black-tailed Jack Rabbit, *Lepus californicus*.

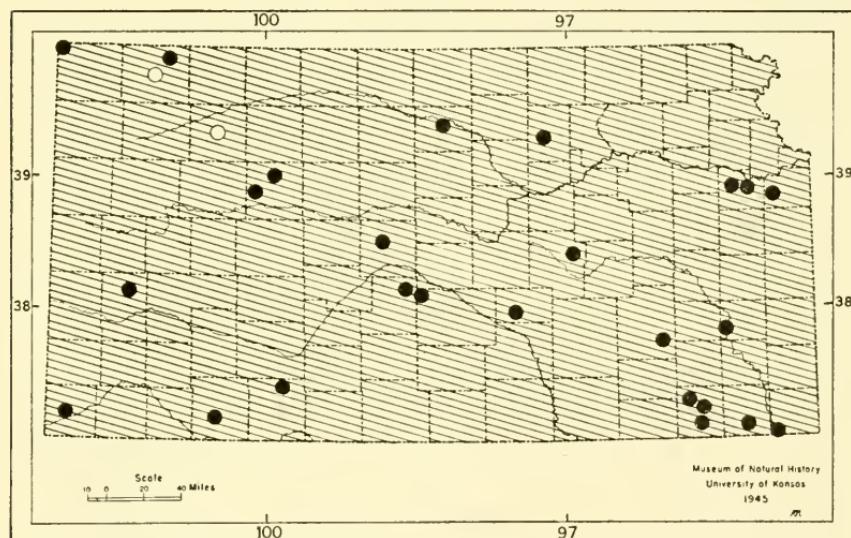
Black-tailed Jack Rabbit

Lepus californicus Gray

This species avoids timber and prefers open grassland. Consequently there are more Black-tailed Jack Rabbits in western Kansas, a part of the Great Plains, than in the more wooded eastern part of the State. In Kansas the population fluctuated; that is to say the numbers of Black-tailed Jack Rabbits would increase year after year for several years and then in a period of only a few months or less the animals would die off. Contrary to popular belief, the length of the period of increase was not always the same; it varied from a few to many years. In periods when the numbers were large, farmers who cultivated fields that were surrounded by, or that adjoined, large areas of grassland suffered losses to their crops. As more and more of the land was cultivated, losses from jack rabbits declined. Tilling of the land had a deleterious effect on them.

In the late part of the 19th century and early part of the present century, at times when jack rabbits were abundant, many thousands were killed and shipped to large cities where the rabbits were

sold as food. For example, in the winter of 1894-1895, approximately 20,000 jack rabbits (4 or 5 railroad cars full) were shipped to market. In general, Jack Rabbit drives were arranged and carried out as follows. A pen with woven-wire sides was built. From a narrow opening on one side, two "wings" of wire fence were set up in the shape of a V. By prearrangement a line of persons converged on the wide end of the V driving the rabbits before them into the pen. There the animals were killed. It is said that more than 10,000 rabbits were obtained in each of several such drives. In periods when jack rabbits were so abundant as to damage crops, some counties paid bounties on rabbits. In four months in 1877-1878, Doniphan County paid \$1,300.00 on 65,000 rabbits.



Description.—Total length, 510-582; tail, 60-80; hind foot, 125-131; ear from notch, 109-113; weight (males of subspecies *deserticola* from Nevada), 3 to 4½ lbs; females ¼ pound heavier. Upper parts ochraceous buffy overlaid with blackish; sides clearer buff; underside of neck cinnamon or ochraceous buff; remainder of under parts, front of hind legs and tops of hind feet pure white; posterior half of ears white with short black patch at tip; rump whitish or pale gray with mid-dorsal black band extending over upper side of tail; animals from western Kansas paler than described above but with same color pattern; occlusal (chewing) surface of first upper incisor revealing a simple groove in enamel of anterior face of tooth.

Lepus californicus melanotis is the only subspecies in Kansas and it was named by Mearns (Bull. Amer. Mus. Nat. Hist., 2:297, February 21, 1890) with type locality at Independence, Montgomery County, Kansas.

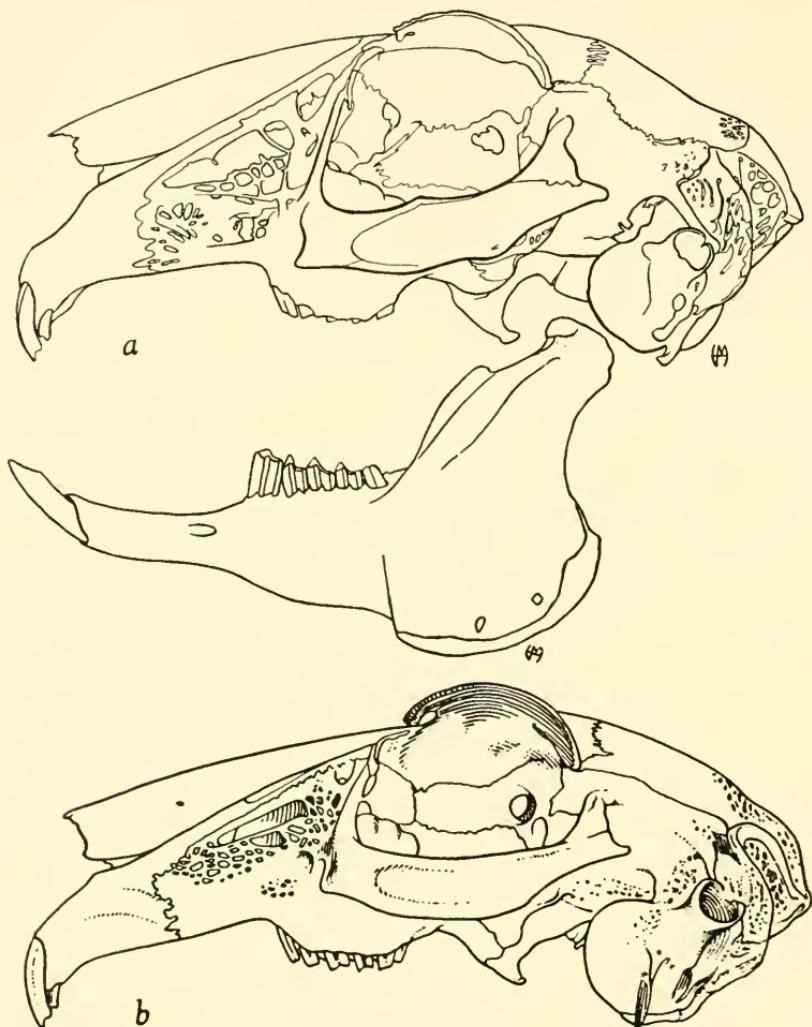


FIG. 15. Lateral (side) views of skulls, one with lower jaw, of two jack rabbits, natural size.

- a. White-tailed Jack Rabbit, *Lepus townsendii* [subspecies *townsendii* Bachman], N end Ruby Valley, E base Ruby Mts., Elko County, Nevada, ♀, No. 45746 University of Kansas Museum of Natural History.
- b. Black-tailed Jack Rabbit, *Lepus californicus* [subspecies *texianus* Waterhouse], E base Burro Mesa, 3500 ft., Big Bend, Brewster County, Texas, ♂, No. 81694 California Museum of Vertebrate Zoology.

ORDER RODENTIA

KEY TO FAMILIES OF RODENTS

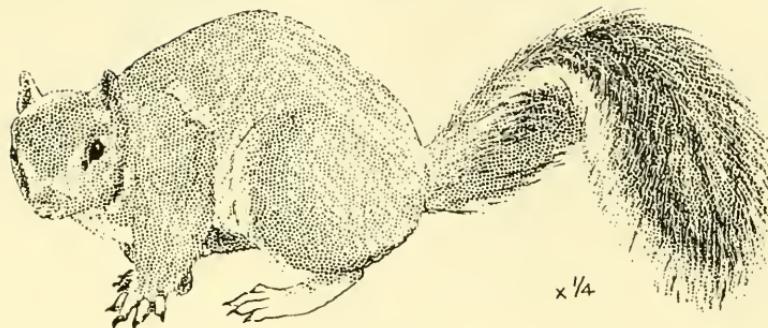
1. Body and tail without quills; facial opening of infraorbital canal smaller than foramen magnum.
2. Hair on middle of tail longer than diameter of fleshy part of tail at that point; skull with well-developed postorbital processes on frontal bones Sciuridae, page 78
- 2'. Hair on middle of tail shorter than diameter of fleshy part of tail at that point; skull lacking postorbital processes on frontal bones.
3. External fur-lined cheek-pouches present; auditory bulla longer than crown surface of upper cheek-teeth and longer than incisive foramina.
4. Tail less than $\frac{3}{4}$ length of head and body; claws on forefeet more than $1\frac{3}{4}$ as long as those on corresponding toes of hind feet; nasals even with, or projecting barely beyond, incisors; auditory bullae not exposed on parietal face of skull Geomyidae, page 103
- 4'. Tail more than $\frac{3}{4}$ length of head and body; claw on forefeet less than $1\frac{3}{4}$ as long as those on corresponding toes of hind feet; nasals projecting much beyond incisors; auditory bullae exposed on parietal face of skull Heteromyidae, page 107
- 3'. No external fur-lined cheek-pouches; auditory bulla shorter than crown surface of upper cheek-teeth or shorter than incisive foramina and usually shorter than either.
5. Tail flattened (fleshy part several times wider than deep); incisive foramen shorter than occlusal surface of first two upper cheek-teeth Castoridae, page 115
- 5'. Tail not flattened; incisive foramen longer than occlusal surface of first two upper cheek-teeth.
6. Tail equal to or less than length of head and body; cheek-teeth, $\frac{3}{4}$.
7. Annulations on tail nearly or completely concealed by hair; cheek-teeth with cusps (or prisms that remain when cusps are worn down) in two longitudinal rows Cricetidae, page 120
- 7'. Annulations on tail revealed by sparsity of hair; cheek-teeth with cusps in three longitudinal rows Muridae, page 153
- 6'. Tail longer (by one-fifth) than head and body; cheek-teeth $\frac{3}{4}$ (in Kansas) Zapodidae, page 160
- 1'. Body and tail with quills; facial opening of infraorbital canal larger than foramen magnum Erethizontidae, page 162

FAMILY SCIURIDAE—KEY

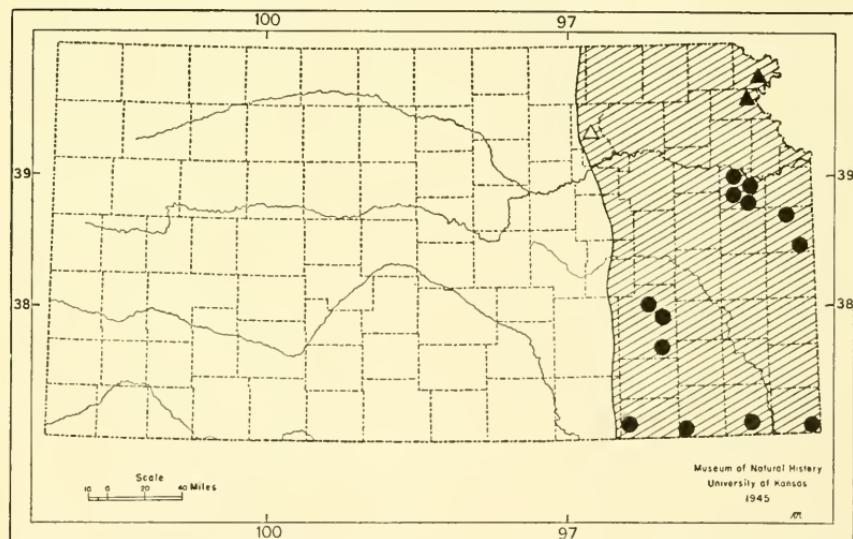
1. Hind foot more than 75; posterior margin of postorbital process of frontal at right angle with long axis of skull	Woodchuck, page	84
1'. Hind foot less than 75; posterior margin of postorbital process of frontal inclined posteriorly and downward.		
2. No loose fold of skin on side between fore- and hind-leg; diameter of external auditory meatus less than length of occlusal surfaces of 2½ upper molars.		
3. Crown of second upper molar as long as wide.		
4. Hairs on side of tail tipped with white; P3 usually present	Gray Squirrel, page	79
4'. Hairs on side of tail not tipped with white; P3 absent	Fox Squirrel, page	81
3'. Crown of second upper molar wider than long.		
5. Underparts white; always striped above; P3 absent	Eastern Chipmunk, page	98
5'. Underparts grayish red; striped or mottled or plain above; P3 present.		
6. Tail less than a fourth of total length; rows of upper cheek-teeth strongly convergent posteriorly; P3 enlarged, complex, with 4 ridges	Black-tailed Prairie Dog, page	87
6'. Tail more than a fourth of total length; rows of upper cheek-teeth not strongly convergent posteriorly; P3 simple, peglike.		
7. Total length more than 325; upper molariform tooth-row more than 8.5.		
8. Tail (minus hair at tip) less than 7/10 as long as head and body; height of ear from notch less than 13; anterior upper premolar (P3) bearing two cusps and a cutting edge; P3 more than ¼ size of P4	Franklin's Ground Squirrel, page	95
8'. Tail (minus hair at tip) more than 7/10 as long as head and body; height of ear from notch more than 13; anterior upper premolar (P3) simple (a single principal cusp); P3 less than ¼ size of P4 (not yet found in Kansas)	Rock Squirrel, page	246
7'. Total length less than 325; upper molariform tooth-row less than 8.5.		
9. Upper parts striped; postorbital constriction less than 12	13-lined Ground Squirrel, page	90
9'. Upper parts with indistinct spots; postorbital constriction more than 12	Spotted Ground Squirrel, page	93
2'. Fold of skin on side between fore- and hind-leg; diameter of external auditory meatus amounting to length of occlusal surfaces of 2½ or more molars	Southern Flying Squirrel, page	101

Genus *Sciurus* Linnaeus

Gray Squirrel

Sciurus carolinensis Gmelin

This species occurs in the remaining stands of oak-hickory woods. It lives also in parks in towns even though there be few or no oaks or hickories. Because White Man has cut out much of the oak and



Riley County (no exact locality specified) and Cedar Vale in Chautauqua County are the two westernmost record stations of occurrence.

Description.—Total length, 425-464; tail, 184-212; hind foot, 61-66; ear from notch, 28-33. Upper parts grayish tinged with pale rusty brown on back; tips of hair on tail and tips of tuft of hair behind ear whitish; usually five cheek-teeth on each side of upper jaw (two being premolars, the front one of which is a minute peg—this peg is lacking in the Fox Squirrel).

hickory, the Gray Squirrel is less abundant than it was originally. The second growth timber, of which elms form a major part, support Fox Squirrels but few or no Gray Squirrels.

It is my impression that the Gray Squirrel depends, even in summer, on holes in trees for shelter and that it spends less time on the ground than does the Fox Squirrel. Nuts, acorns, buds and fruits are preferred foods.

Mating occurs in midwinter and after a gestation period of 44 days the three to six young are born in a nest of leaves or in a nest in a hole in a tree. It is thought that there is often a second litter in late summer.

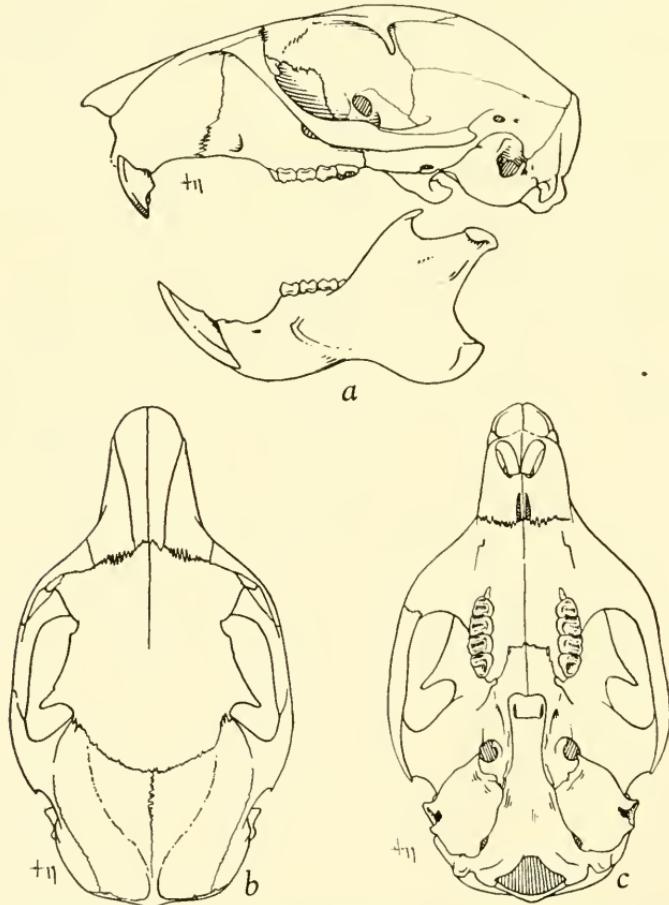
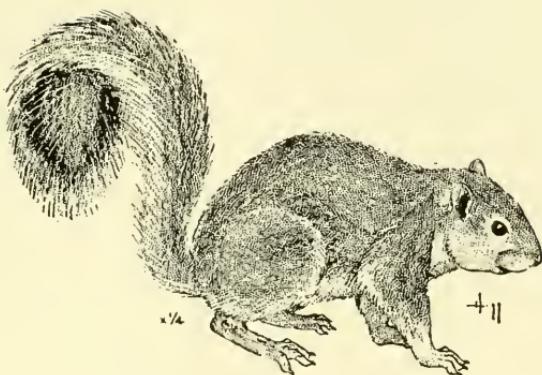


FIG. 16. Skull of Gray Squirrel, *Sciurus carolinensis carolinensis* Gmelin, 5 mi. NW Fall River, Greenwood Co., Kansas, ♂, No. 9637 KU, natural size.

Sciurus carolinensis carolinensis is the only subspecies in Kansas and was named by Gmelin (Systema Naturae, 1:148, 1788) from "Carolina".

Fox Squirrel

Sciurus niger Linnaeus

In Kansas this is the common tree squirrel. The population is progressively more dense to the eastward because timber is progressively more abundant in that direction. The Fox Squirrel spends much of its time on the ground searching for, and burying, food. Although nuts are an important part of the food, buds, mushrooms and other plants are eaten in season. Field corn is levied upon and the seeds of the round fruits of the introduced Osage orange are eaten. At Hays, in western Kansas, there are few nut trees or oaks but the Fox Squirrel thrives there and in late summer and autumn eats hackberry nippiegalls, cedar berries, pods of honey locust, bark of Russian olive trees, and seeds of the wild gourd. Food in summer includes petiole galls on the seeds of cottonwood and hackberry. In winter and spring elm seeds and buds and fruits of the Russian olive were eaten.

The summer home is a loosely built shelter of leaves in a tree. In autumn the Fox Squirrel moves to a cavity in a tree or constructs a substantial outside nest of leaves, twigs and branches.

Mating occurs in January and two to four young are born late in February or early in March.

Squirrel hunting is permitted in summer because the young animals then are tender as well as tasty. Autumn, after the foliage of the trees has turned red, is the time when skill in hunting and marksmanship can best be tested. The similarity in color of the leaves and coat of the Fox Squirrel tends to conceal the latter. Also the squirrels are wary and when closely approached they lie still on limbs. To see the animals requires sharp vision. The hunter, of course, uses only a small caliber rifle and clean kills

are best made by head shots; the novice can bring home a nearly empty bag from timber in which there is a large population of the Fox Squirrel. For hunting, an open season of September 1 through December 10 would be preferable to the present season of June 15 through November 30, according to Mr. Robert L. Packard, a student in Zoology at the University of Kansas. In the account of his two-year study just completed as I write (1955), he points out that

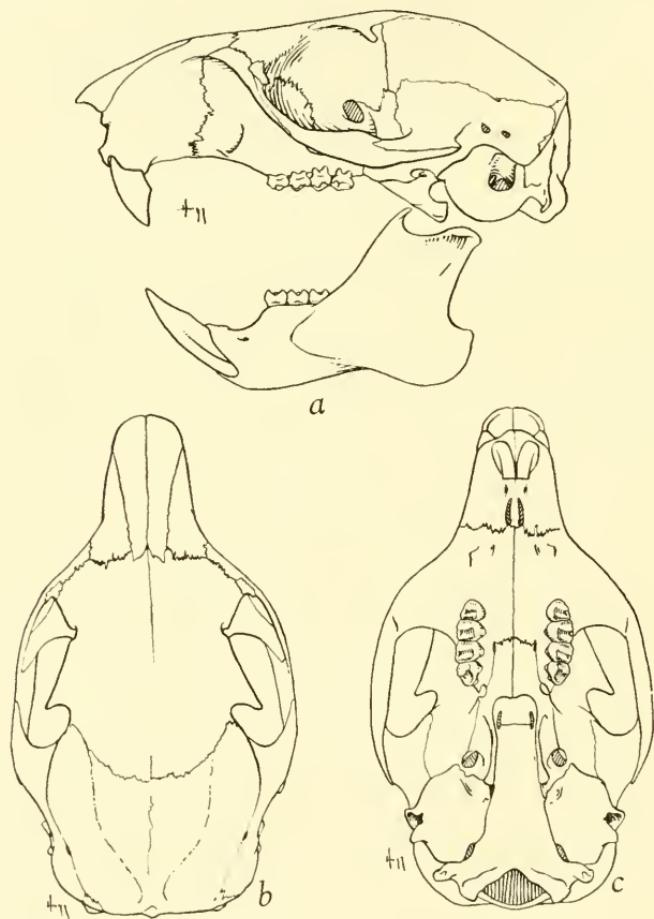
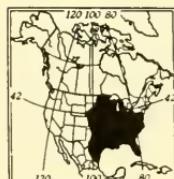
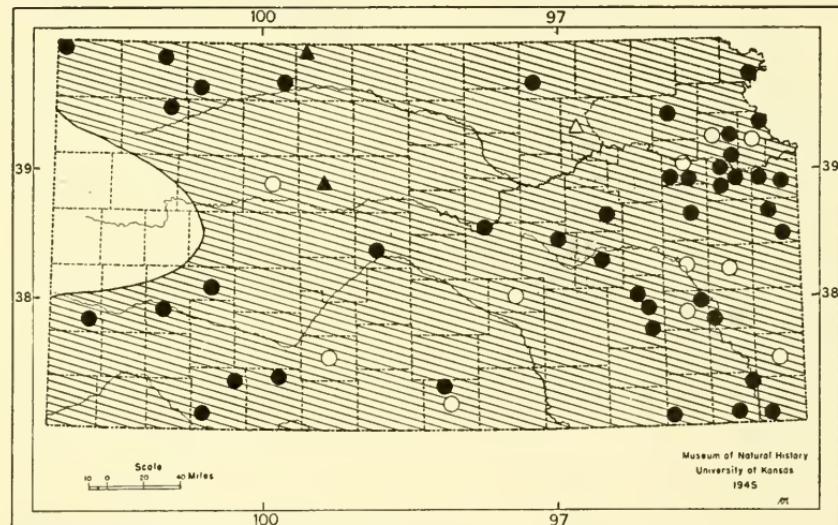


FIG. 17. Skull of Fox Squirrel, *Sciurus niger rufiventer* Geoffroy, 6 mi. S and 6 mi. W Oberlin, Decatur Co., Kansas, ♂, 19027 KU, natural size.

many young still are nursing in June, July and August and perish if their mothers are killed then. He learned also that the reproductive season is later in some years than in others. Therefore he concludes

that a field investigation each year might well be made to ascertain when the breeding period ends, so that the end of the nursing period can be calculated. With this information the opening of the hunting season can be set two months or more beforehand and at a time when young can look after themselves. As a result there will be more Fox Squirrels. Two and three are the numbers of young common in litters. A Fox Squirrel born in late February is almost full grown in the following September when the weight is approximately one pound two ounces. In September slightly more than half of all Fox Squirrels are less than one year old. Weights are most in autumn when food is abundant and are less in winter when food is scarce. In counties having both species of squirrels, there are approximately 11 Fox Squirrels for every Gray Squirrel.



Description.—Total length, 460-564; tail, 180-251; hind foot, 64-75; ear from notch, 24-30. Upper parts reddish or fulvous, grizzled with grayish; tips of hair on tail and tips of tuft of hairs behind ear fulvous; four cheek-teeth on each side of upper jaw (only one premolar).

Three record stations of occurrence (see the map) recently established for this species are: Hamilton Co., sec. 27, R. 39, T. 25; Finney Co., 11 mi. N and 22 mi. E Garden City; and sec. 24 R. 33, T. 24. Specimens were obtained from these three localities in the winter of 1953-54 for the University of Kansas Museum of Natural History by Mr. R. L. Packard of the State Biological Survey.

In Kansas there is only one subspecies, *Sciurus niger rufiventris*. It was named by Geoffroy (Catal. Mamm. Mus. Hist. Naturelle Paris, p. 176, 1803) on the basis of specimens from the Mississippi Valley.

Genus *Marmota* Blumenbach
Woodchuck
Marmota monax (Linnaeus)



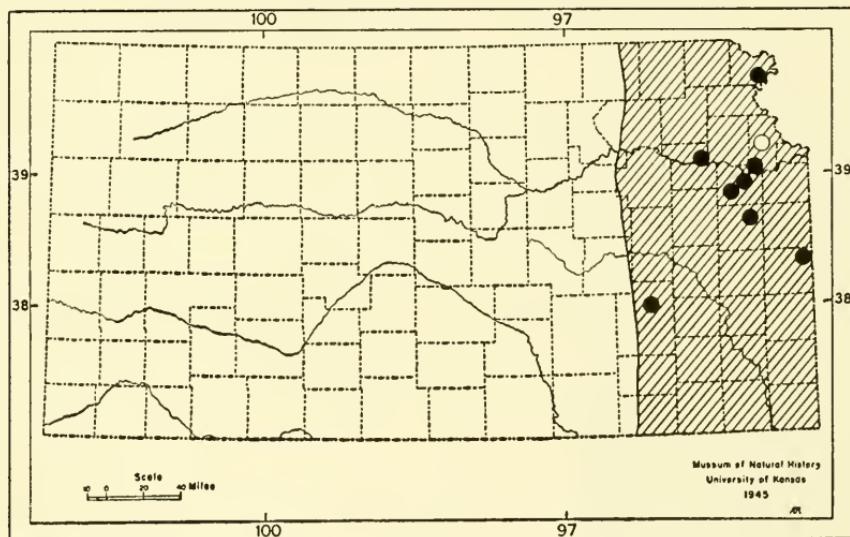
The Woodchuck is most consistently active at sunup but may be seen at any other time of day. The animal digs its own burrow; most burrows have more than one entrance. A burrow more than 30 feet long and between five and six feet deep has been recorded. Some that enter cut banks are deeper than 6 feet. One Woodchuck makes more than one burrow in a lifetime. These burrows are the homes or retreats of Opossum, cottontail, two species of skunks, Red Fox and other species.

By autumn the Woodchuck is notably fat. In the hibernation nest where the Woodchuck spends the winter, the fat is used up by the time spring has arrived and the animal then is lean. If he happens to perform according to the legend and comes out on Groundhog Day (February 2) and looks for his shadow, the width of his shadow will be hardly half so wide as it was in autumn when he was almost too fat to run.

Green plants are the food of Woodchucks and those that live in the vicinity of gardens often eat the tops of growing vegetables. A professor friend of mine, whose wife's garden was thus levied upon, borrowed steel traps and with these and a rifle temporarily eliminated most of the Woodchucks. But the area was suitable Woodchuck terrain and so others moved in the following year. A neighboring professor erected a fence of woven wire, four feet high with two-inch mesh, around his wife's garden and so protected it from all woodchucks except one that happened to bring its burrow up just inside the fence. The wife of still another professor nearby, planted two rows of soybeans around her garden. When-

ever the Woodchucks that lived in an adjacent burrow wanted cultivated plants they ate the soybeans. This lady's system seemed to me the very best since it propagated both the garden vegetables and the Woodchucks. Also, she gave her husband no trouble about adjusting differences between her and the woodchucks. The fencing system, however, had the merit of excluding also cottontail rabbits that might not prefer soybeans to lettuce or peas. Consequently, when it is desired both to encourage wild life and to have a garden, the fence seems best.

Mating occurs in March and April. Two to eight young, usually four or five, are born in April or May after a gestation period of approximately four weeks. Young at birth weigh only 26 grams.



Description.—Total length, 555-653; tail, 102-189; hind foot, 85-96; ear, 26-35; weight, up to 9 lbs. 12 ounces. Body grayish resulting from guard hairs having a black band succeeded by an apical band of light buff; legs hazel; feet, tail and forehead and face black; there are five cheek-teeth in each side of the upper jaws and four in each side of the lower jaw. Among the members of the squirrel family in Kansas, adult Woodchucks can be recognized by their large size.

The range includes only the eastern fourth or less of the State—the fourth in which the timber is tallest and most abundant. Hamilton, Greenwood County, is the westernmost place from which an actual specimen has been seen. On May 16, 1947, however, Mr. A. A. Steinbrook of Route 1, Abilene, Kansas, told me that he once saw a Woodchuck along the [Kansas] River where it changes direction 7 to 8 miles southeast of Manhattan. This locality is not shown by a dot on the distribution map.

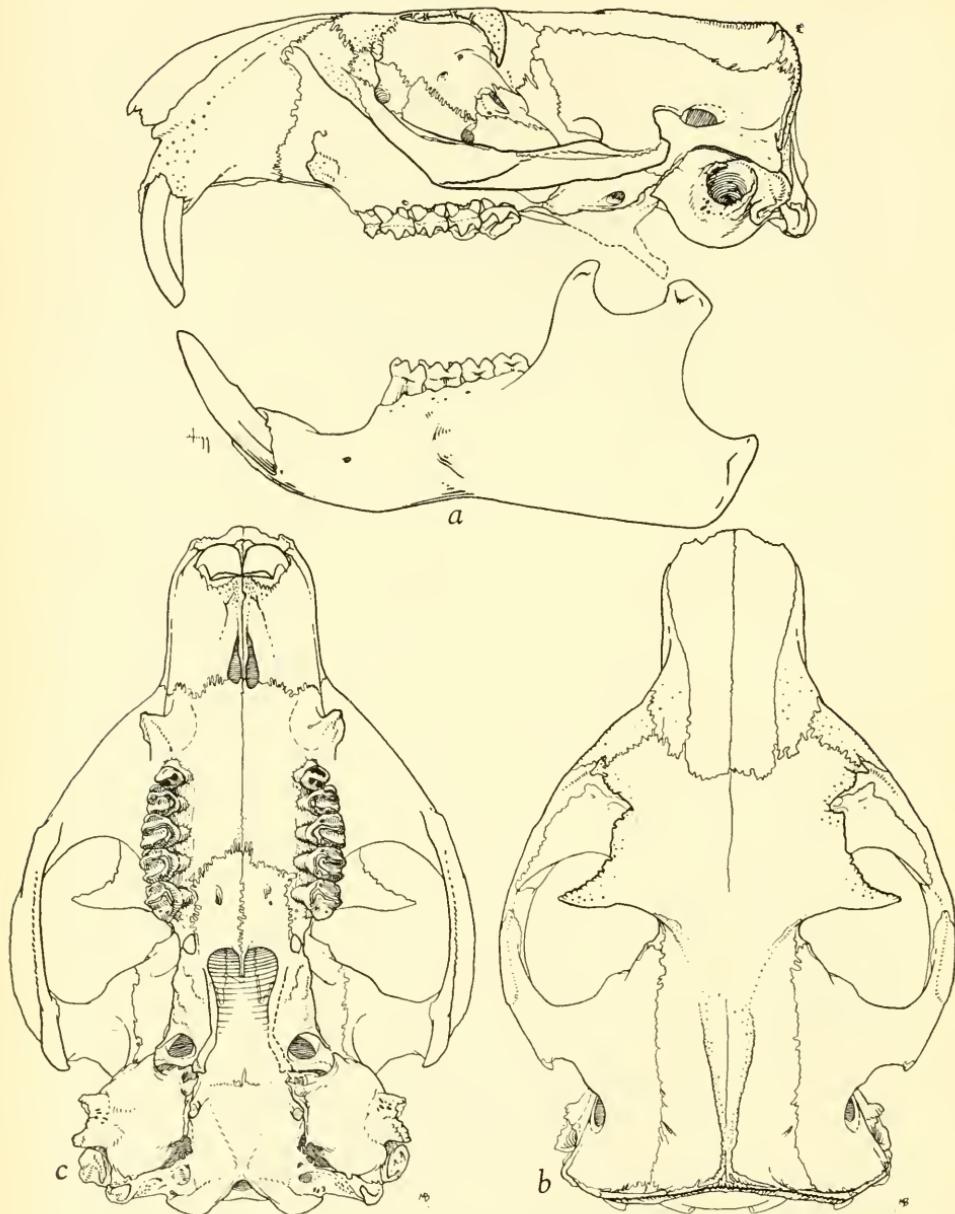
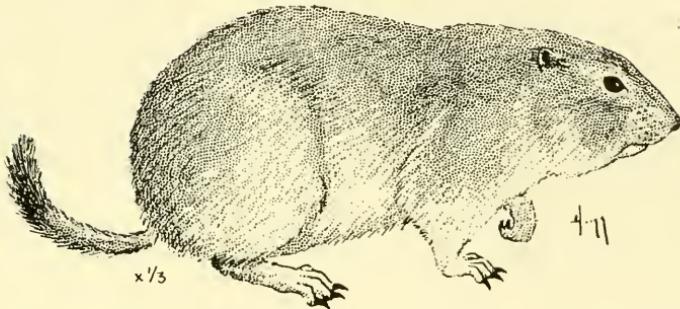


FIG. 18. Skull of Woodchuck, *Marmota monax* [subspecies *monax* (Linnaeus)], 3 mi. W and 3 mi. N Wilmington, Ohio, ♀, 81418 MVZ, natural size.

The only subspecies in the State is *Marmota monax bunkerii* named by Black (Jour. Mammalogy, 16:319, November 15, 1935) with type locality seven miles southwest of Lawrence, Douglas County, Kansas.

Genus *Cynomys* Rafinesque

Black-tailed Prairie Dog

Cynomys ludovicianus (Ord)

The Prairie Dog is colonial, living in "towns." A typical burrow consists of a shaft that extends almost straight down for as far as ten feet where there is a horizontal tunnel. The excavated earth is piled in a circle around the mouth of the hole. When rain or melting snow floods the area the excavated earth serves as a dyke that ordinarily prevents flooding of the burrow. On 20 acres in the Upper Solomon Valley the naturalist Theo. Scheffer counted 100 Prairie Dogs and 334 holes.

Prairie Dogs do not live where the ground is soft and more especially where the grass grows so tall that the Prairie Dogs can not see over it. The animal is an inhabitant of the short-grass plains. In the long-grass areas of Kansas, Prairie Dogs lived where the Bison cropped the grass short and trampled the soil until it was hard. Later, overgrazing by cattle similarly made a habitat favorable for the Prairie Dog. Those stockmen who overgraze their ranges seek to eliminate the Prairie Dog because it competes with livestock for food; both prefer green vegetation. Consequently, the Prairie Dog has been exterminated over much of its original range in Kansas. Actually, when the range is grazed only to the extent that some forage is left for a terminally dry season, so that livestock will not starve if unusually dry conditions occur, there is in most years sufficient food for both the Prairie Dogs and domestic livestock. Concerning this animal, as I recall in the Dakotas, the late Theodore Roosevelt once wrote of vast towns of Prairie Dogs that gradually and slowly moved across the plains. The air, and water with its contained solvents, that entered the ground enriched the soil and caused a much better growth of

grass in the wake of the Prairie Dog town than there was in front of it. The suggestion is that on the prairie where the grass is naturally short, the Prairie Dog is a desirable citizen because he contributes, on a long-term basis, to enriching the soil and thus providing a more abundant growth of forage both for domestic livestock and native wildlife.

Stems of dry grass, by accident or design I do not know, are incorporated in the raised "mound" that surrounds the mouth of the burrow. These mounds, therefore, often have the increased strength that is given to adobe bricks by incorporating dried grass in them.

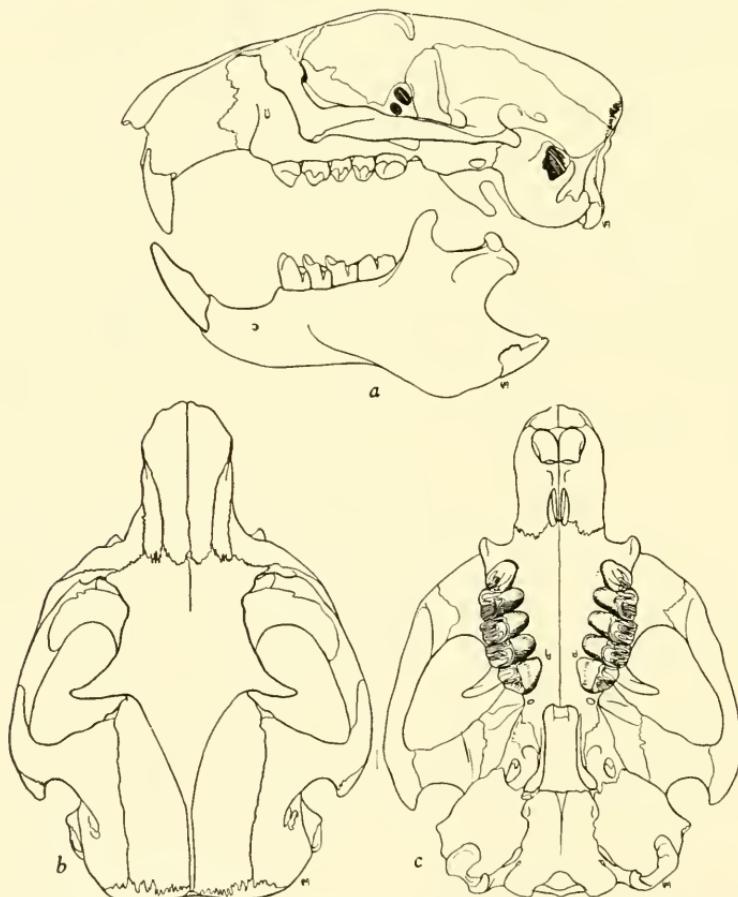
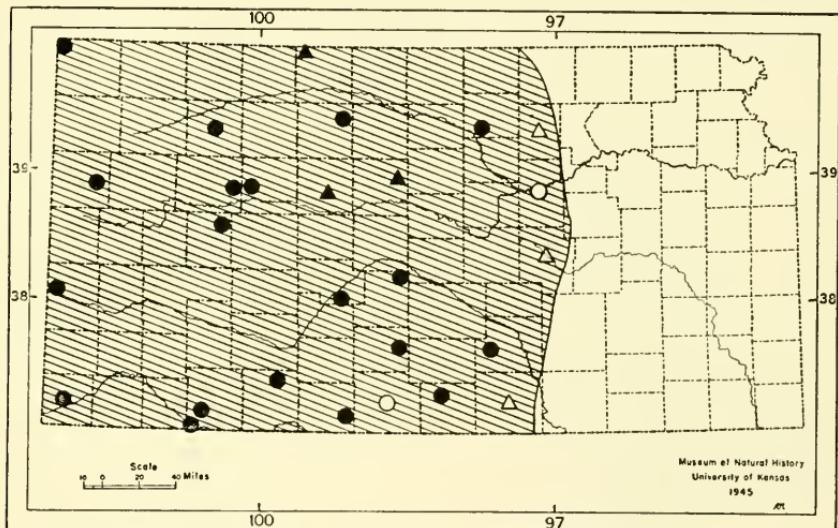


FIG. 19. Skull of Black-tailed Prairie Dog, *Cynomys ludovicianus ludovicianus* (Ord), Higgins, Lipscomb Co., Texas, ♀, No. 44365 MVZ, natural size.

Black-tailed Prairie Dogs mate in February, March and April. After a gestation period of 28 to 32 days, two to 10 young, usually five or six, are born in a nest below ground. From May 15 to June 15, families of young less than half grown can be seen above ground. In autumn the young weigh approximately two-thirds as much as adults and attain adult size in the second summer. According to John A. King, who studied this species in South Dakota, two to 35 individuals live together without showing antagonism to one another in what he termed a "coterie". Territory occupied by a coterie is defended against non-members. Movements of a member of a coterie are unrestricted within it. Prairie dogs are diurnal and slightly more than half of their time above ground is spent in eating. They are less active above ground in winter than in other seasons.



Easternmost record stations of occurrence are in Clay, Dickinson (Coyote Station), Marion and Sumner counties.

Description.—Total length, 300-380; tail, 54-85; hind foot, 53-60; weight, 1½ to 3 lbs. Upper parts dark pinkish cinnamon finely lined with black and buff; underparts whitish or buffy white; terminal third of tail black; two molts per year; winter pelage less ochraceous being more buff and gray; upper rows of teeth strongly convergent posteriorly.

In Kansas there is only the one subspecies, *Cynomys ludovicianus ludovicianus*, named by Ord in 1815 (Guthrie's Geography, 2nd American ed., 2:292, description on p. 302) on the basis of specimens thought to have come from along the upper Missouri River.

Ground Squirrels

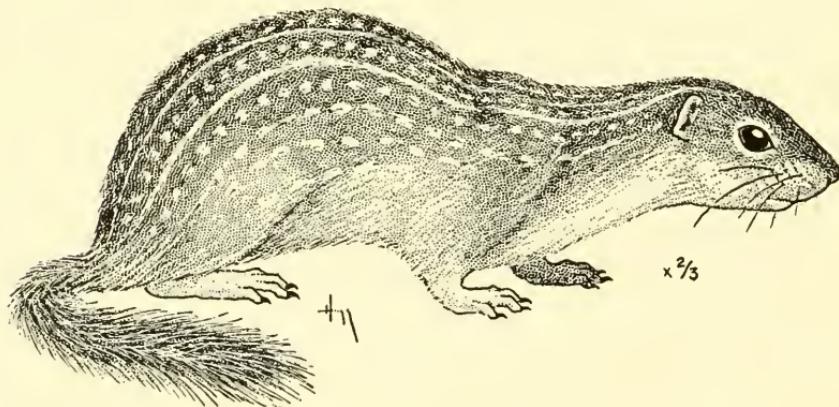
Genus *Spermophilus* F. Cuvier

Three species occur in Kansas. Those that have stripes can be distinguished from chipmunks (*Genera Tamias* and *Eutamias*) by the absence of stripes on the side of the head. Chipmunks have stripes on the head as well as on the body. On each side of the upper jaw of a ground squirrel there are five cheek-teeth and four on each side below.

All are diurnal species that live in the ground in burrows dug by themselves. Green vegetation is the principal food although seeds are eaten to some extent and at least one species, *S. tridecemlineatus*, subsists mostly on insects at certain times. All three of our species hibernate.

13-lined Ground Squirrel

Spermophilus tridecemlineatus (Mitchill)



This species occurs on native prairies and closely mown grass-lands. Individuals live a solitary existence instead of in colonies. One animal may dig several burrows; some are shallow and are used for temporary shelter whereas others are deeper, more elaborate and are for regular use. A "home" burrow may be 20 feet long and as much as three feet deep. The nest is of dry grass.

Forty years ago in Franklin County this squirrel and Upland Plover both were common. Land allocated for roads was fenced on two sides. The road proper, unpaved, was in the middle of the strip; the rest of the strip was native prairie. The 13-lined Ground Squirrel

and plover lived in this prairie. Now the strips of prairie are gone and so are the plover and most or all of the ground squirrels.

No other species of mammal has yielded more information about hibernation than the 13-lined Ground Squirrel.

In hibernation the 13-lined Ground Squirrel becomes torpid. The rate of breathing, rate of heart beat and all bodily processes are slowed to only a fraction of the rate that obtains when the

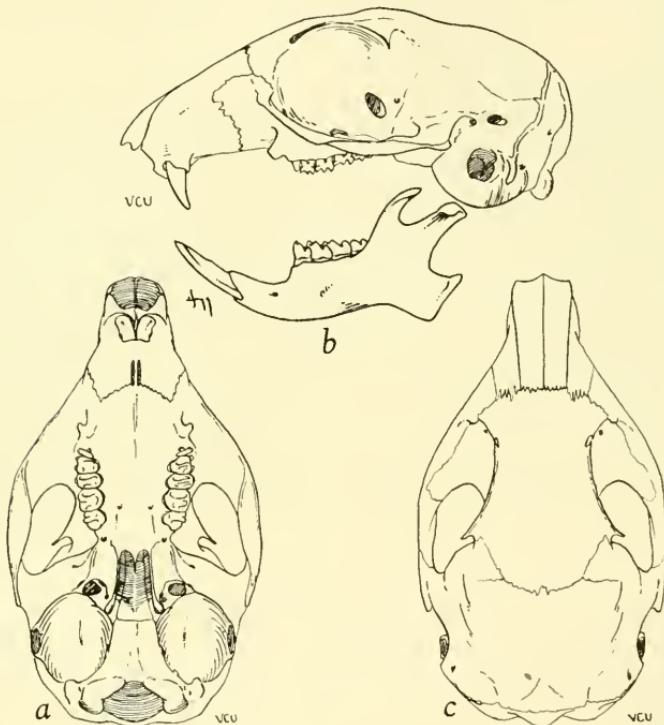
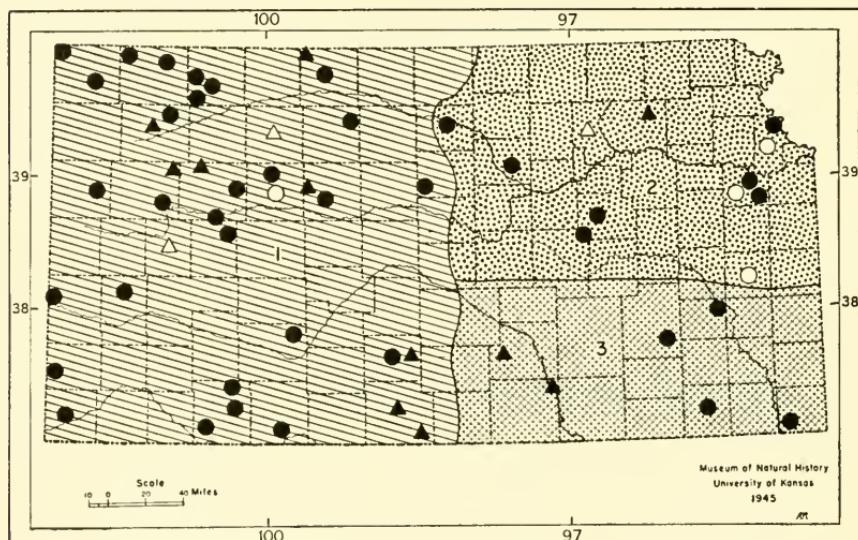


FIG. 20. Skull of 13-lined Ground Squirrel, *Spermophilus tridecemlineatus arenicola* (A. H. Howell), 6 mi. W Bird City, Cheyenne Co., Kansas, ♂, No. 12079 KU, $\times 1\frac{1}{2}$

animal is active. The temperature drops to approximately as low as the temperature of the immediate surroundings. The hibernation nest of dry grass and plant fibers is underground, usually below the frost-line. The 13-lined Ground Squirrel curls up like a watch spring and rests on edge on the lower part of the back and top of the head. This species stores food and at least some individuals awaken for short periods of a few hours every few (two to twelve) days and eat some of the stored food.

In summer the food consists of seeds, green plants and insects; more than half of the food is made up of insects at certain times. Insects harmful to cultivated plants sometimes make up a large share of the food of the 13-lined Ground Squirrel and knowledge of this fact has caused many, but by no means all, persons to regard this species as beneficial to the farmer.

Mating occurs in April. After a gestation period of 28 days, 5 to 13 (usually six to ten) young are born in an underground nest.

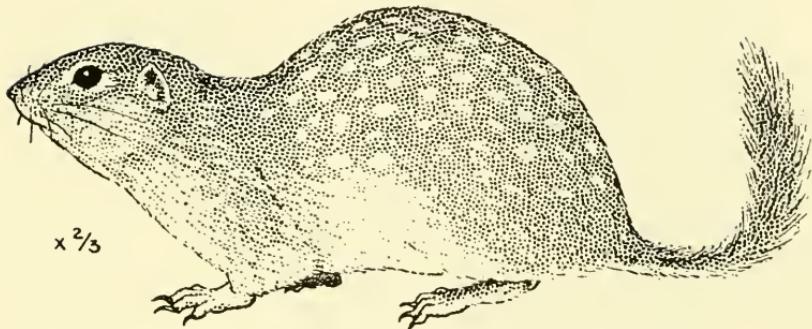


Distribution of *Spermophilus tridecemlineatus*.
1. *S. t. arenicola*. 2. *S. t. tridecemlineatus*. 3. *S. t. texensis*.

Description.—Total length, 229-295; tail, 61-118; hind foot, 31-36; ear from notch, 8-10; weight, up to 109 grams. Upper parts with five dark longitudinal stripes and a series of squarish white or buffy-white spots extending down median line of each stripe; approximately six narrower whitish stripes alternating with dark stripes mentioned above; some additional indefinite stripes on sides. Least width of skull across frontal bones immediately behind post-orbital processes less than 12 mm.

There are three subspecies in Kansas. *Spermophilus tridecemlineatus arenicola* (A. H. Howell) (Proc. Biol. Soc. Washington, 41:213, December 18, 1928), with type locality at Pendennis, Lane County, Kansas, occurs in the western half of the State. *S. t. tridecemlineatus* (Mitchill) (Medical Repository (n.s.), 6(21):248, 1821), the type of which came from central Minnesota, occurs in the northeastern quarter of the State. *S. t. texensis* Merriam (Proc. Biol. Soc. Washington, 12:71, March 24, 1898) with type locality at Gainesville, Cooke County, Texas, occurs in the southeastern quarter of State.

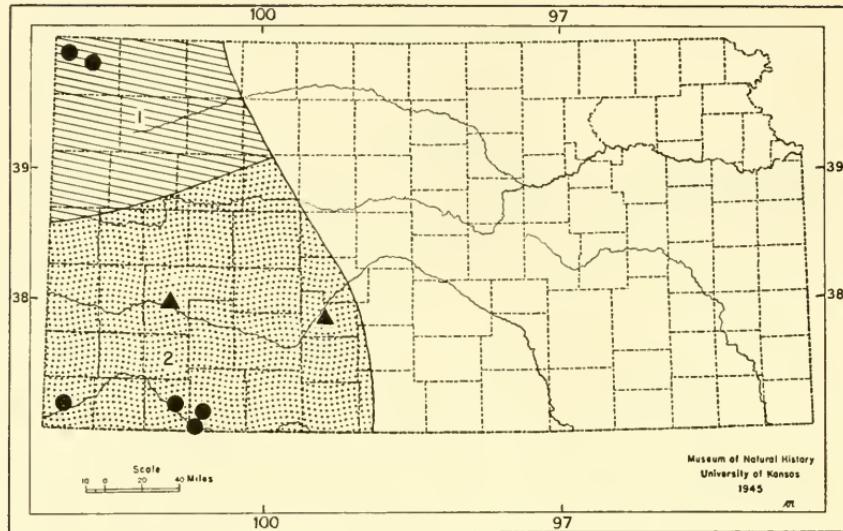
Spotted Ground Squirrel

Spermophilus spilosoma Bennett

In Kansas the Spotted Ground Squirrel occurs in the western third of the State; more precisely it is known from as far east as Kinsley in Edwards County and west of a line drawn from there to a point five and one-half miles northeast of St. Francis in Cheyenne County from where it was recorded by Jones and Loomis (Trans. Kansas Acad. Sci., 56:107, March 21, 1953). None of the field parties from the Museum of Natural History of the University of Kansas ever have found the species to be anywhere so abundant as the Thirteen-lined Ground Squirrel. For example, in the summer of 1922 in Cheyenne County I saw scores and perhaps hundreds of the Thirteen-lined Ground Squirrel but only one Spotted Ground Squirrel although I was making a special search for it.

The Spotted Ground Squirrel lives in burrows usually dug by itself. Green vegetation, seeds, and some insects and their larvae are eaten. Some young that were born to a female that Frank Blair had in captivity opened their eyes on the 27th day, were weaned on or before the 48th day and uttered the trill of adults when no more than 34 days old.

Probably it is significant that ground squirrels as a group live in western North America where vegetation is sparse or if not sparse is low growing. In this part of the continent moisture comes only in one part of the year; there is another period of little or no moisture. Through countless centuries the ground squirrels have become adapted to this climate. In places where there was dense high grass overgrazed by domestic stock, the ground squirrels have become numerous. Where these areas were closed to livestock the grass grew high again and ground squirrels disappeared.



Distribution of *Spermophilus spilosoma*.
1. *S. s. obsoletus*. 2. *S. s. marginatus*.

Description.—Total length, 245-265; tail, 69-80; hind foot, 33-37; ear from notch, 10-11. Upper parts cinnamon to drab, more or less spotted with squarish white spots; underparts white; sides white, in some specimens washed with buff; tail lighter below than above. Least width of skull across frontal bones immediately behind postorbital processes less than 12 mm.

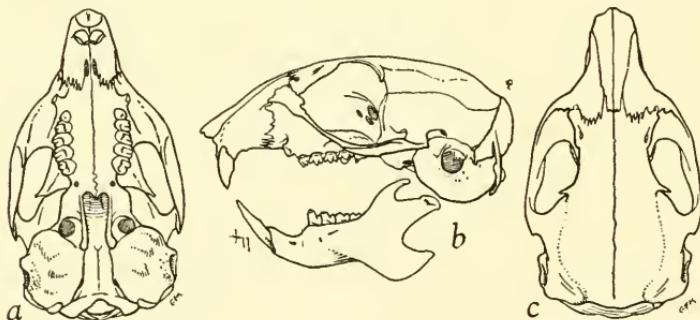
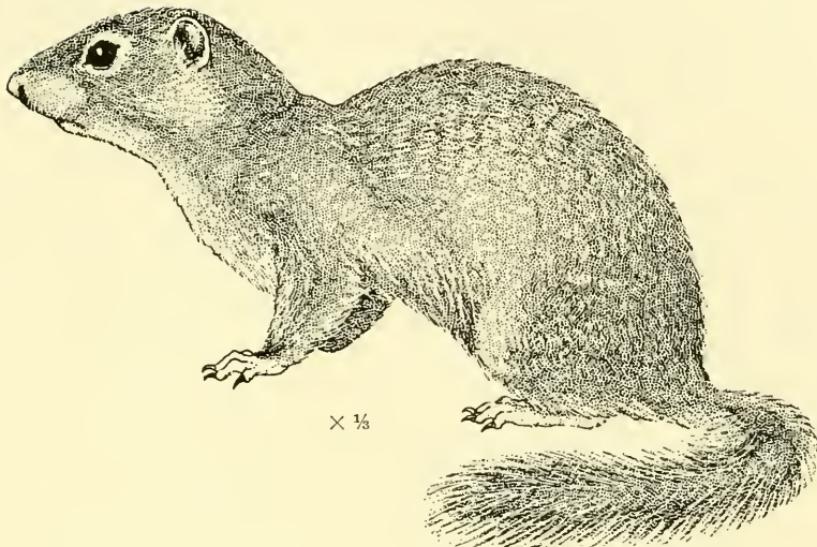


FIG. 21. Skull of Spotted Ground Squirrel, *Spermophilus spilosoma marginatus* Bailey, 2300 ft., N end Mariscal Mt., Brewster Co., Texas, ♀, No. 80346 MVZ, natural size.

Two subspecies occur in Kansas. *Spermophilus spilosoma obsoletus* Kennicott (Proc. Acad. Nat. Sci. Philadelphia, 1863, p. 157), with type locality fifty miles west of Fort Kearney, Nebraska, occurs in extreme northwestern Kansas. *Spermophilus spilosoma marginatus* Bailey (Proc. Biol. Soc. Washington, 15:118, June 2, 1902), with type locality at Alpine, Brewster County, Texas, occurs in southwestern Kansas, as is shown at the top of this page.

Franklin's Ground Squirrel
Spermophilus franklinii (Sabine)



$\times \frac{1}{3}$

In eastern Kansas, Franklin's Ground Squirrel does not, in a strict sense, live in colonies. One that my dog caught one and a half miles south of Le Loup, Franklin County, was the only one seen in the seven years that I lived there. Ordinarily, however, where one is seen a search will reveal six to 10 others within a radius of a quarter of a mile. This species, more than any other one that I know of in the Genus *Spermophilus*, makes its home where the vegetation is so high that the animal cannot see over it and so dense that the animal cannot see through the vegetation for more than a few feet.

As many as ten embryos have been found in one female. The number of young in a litter of average size, however, is thought to be fewer than 10. One female that was moving her young from one burrow to another carried the young belly up; she grasped it with her teeth and the young was partly curled up with the result that its hind feet and tail were on one side of the mother's face and its forelegs were on the other side of her face. Fox Squirrels, and perhaps all tree squirrels, carry their young in the same fashion.

Like other species of ground squirrels, Franklin's Ground Squirrel digs its own burrows. Some individuals, however, have been found living in burrows abandoned by pocket gophers.

Because so little is known of the food habits, and for that matter other habits, Franklin's Ground Squirrel would well repay close study. Certainly it eats some animal matter; one naturalist watched one of these squirrels kill a young cottontail approximately as large as the squirrel and ascertained that the squirrel ate most of the flesh off the hind quarters of the cottontail in 20 minutes. When-

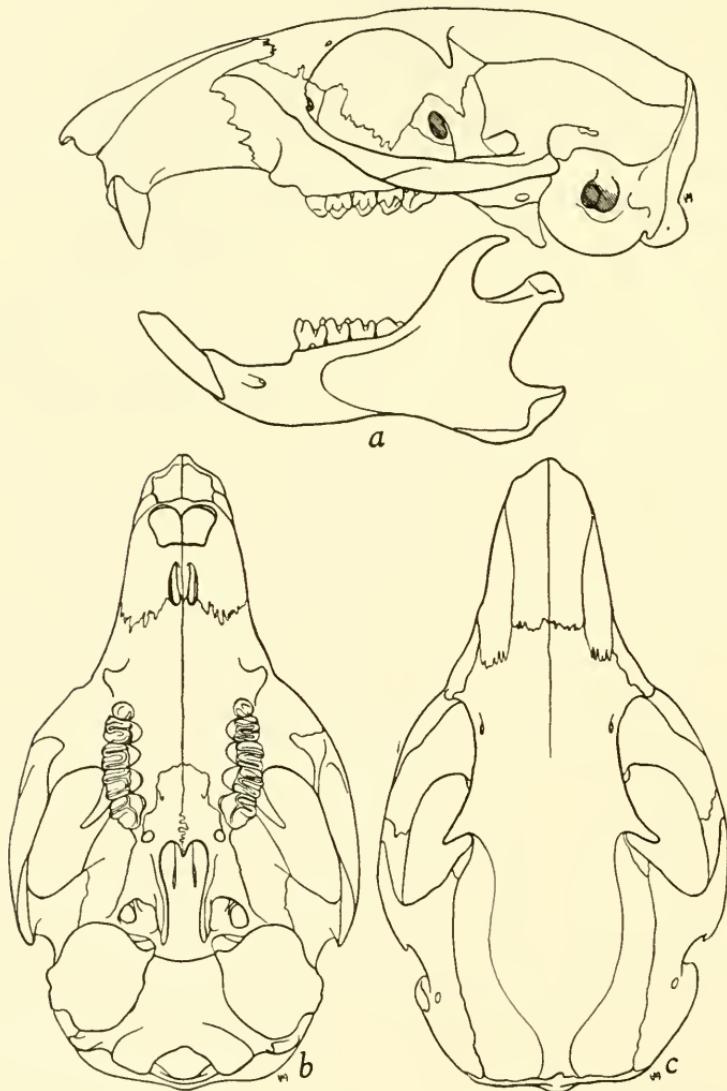
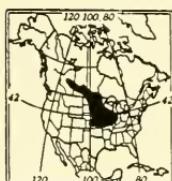
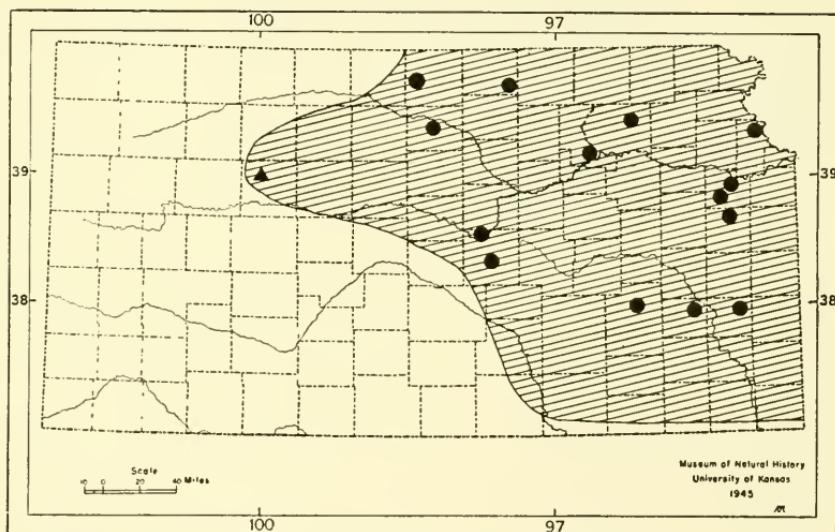


FIG. 22. Skull and left lower jaw of Franklin's Ground Squirrel, *Spermophilus franklinii* (Sabine), Elk River, Sherburne Co., Minnesota, ♂, No. 192703 USNM, $\times \frac{1}{2}$

ever I see one of these ground squirrels there is something about its slenderness and movements that suggests to me the Long-tailed Weasel, which is strictly carnivorous. Therefore, I have often speculated on whether this ground squirrel eats more animal matter than do some other species of ground squirrels.

Natural enemies of Franklin's Ground Squirrel include the Long-tailed Weasel, Red Fox, and Badger. The Badger obtains the ground squirrels by digging them out of their burrows. These burrows left by the Badger provide retreats much used by cottontails, Opossums, and other mammals that obviously owe a part of their comfort to the ground squirrels that lost their lives to the Badger.



Westernmost record stations of occurrence are 20 miles east of Smith Center in Jewell County and nine miles west of Wakeeney, Trego County.

Description.—Total length, 379-412; tail, 123-160; hind foot, 53-56; ear from notch, 16-18; weight, 378-508 grams. Head grayish; back tawny olive or clay color more or less shaded with fuscous; sides buffy or cinnamon; underparts pinkish buff or buffy white; tail blackish above and below but mixed with buff, and overlaid and bordered with creamy white. This is the largest of the three species of ground squirrels in the State. Although superficially similar to the Gray Squirrel (a tree squirrel), Franklin's Ground Squirrel can be distinguished by shorter and less bushy tail, shorter ears, and more buffy sides.

No subspecies have been recognized. The species was named *Arctomys franklinii* by Sabine (Transactions of the Linnaean Society, London, 13:587, 1822) with type locality in the "vicinity of Carlton House," Saskatchewan.

Genus *Tamias* Illiger

Eastern Chipmunk

Tamias striatus (Linnaeus)

Stone fences and ledges in timber that is dense enough to prevent the growth of much grass, where there is hazel brush and some kind of nut-bearing trees make up the preferred habitat. Now, the Eastern Chipmunk is absent from most areas in eastern Kansas where the species formerly occurred. Cattle grazing that exterminated hazel brush in most places, and thinning out trees and cutting of brush to support grass for cattle grazing, are thought to have caused the disappearance of the chipmunk.

Although a family of Eastern Chipmunks can be seen together at certain times, one or two in a place is the rule. The species is not colonial as are the Prairie Dogs. The burrows are difficult to locate and it seems that after one is dug, the original entrance is plugged up and a new entrance is made at the other end where the chipmunk came to the surface. Some burrows are as much as 20 feet long. This species lives mostly on and in the ground and climbs in trees relatively little compared with several of the smaller chipmunks (Genus *Eutamias*) of the western United States. No species of *Eutamias* occurs in Kansas.

The food consists of nuts, acorns, berries, other wild seeds and some insects. In Kansas the animals are said to be active throughout most of the winter although farther north they are known to hibernate for several of the coldest months. Because these chip-

munks store food near the nest (dried leaves and dry grass) in the underground burrow, a person wonders if they wake up at intervals and feed on their stores. In the northeastern United States, some burrows that were opened in winter yielded wide awake chipmunks whereas the animals were dormant in other burrows.

The usual numbers of young are three, four and five. They are born after a gestation period of 31 days.

John Pearce (Jour. Mammalogy, 18:483, 1937) saw a "chipmunk . . . fleeing over the ground not far ahead of a weasel. The chipmunk scampered up a black cherry . . . tree about 10 inches in diameter, climbed to a height of 35 or 40 feet, and escaped to a wide-spreading sugar maple . . . by leaping from a side limb across a space perhaps 6 feet wide. Meanwhile the weasel continued the

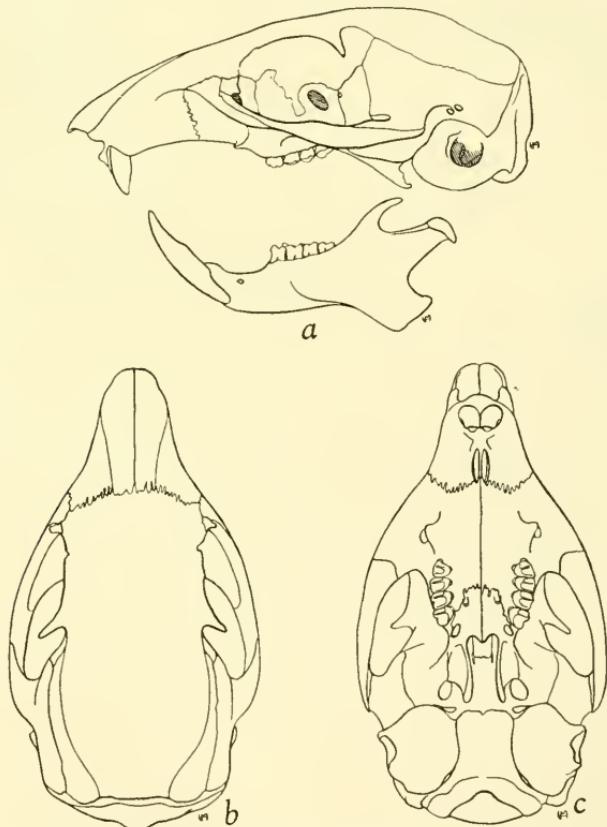
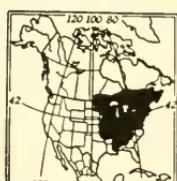
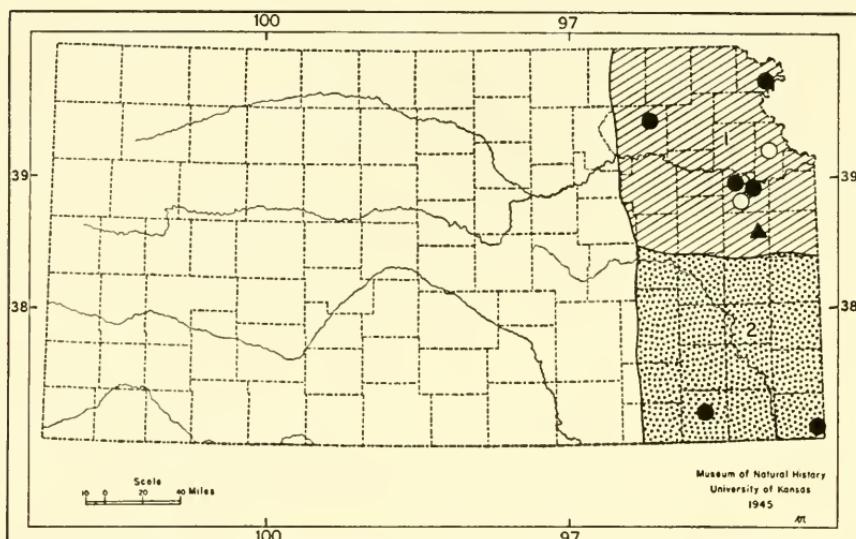


FIG. 23. Skull and left lower jaw of Eastern Chipmunk, *Tamias striatus* [subspecies *lysteri* (Richardson)], 3 mi. SW Phonecia, Ulster Co., New York, ♂, No. 96863 MVZ, $\times 1\frac{1}{2}$.

chase into the cherry tree but at a much slower pace. . . . The weasel, finally confronted with the space leaped by its intended prey, stopped, and after looking across several times, abandoned the pursuit. . . . The chipmunk owed its escape to quicker climbing."



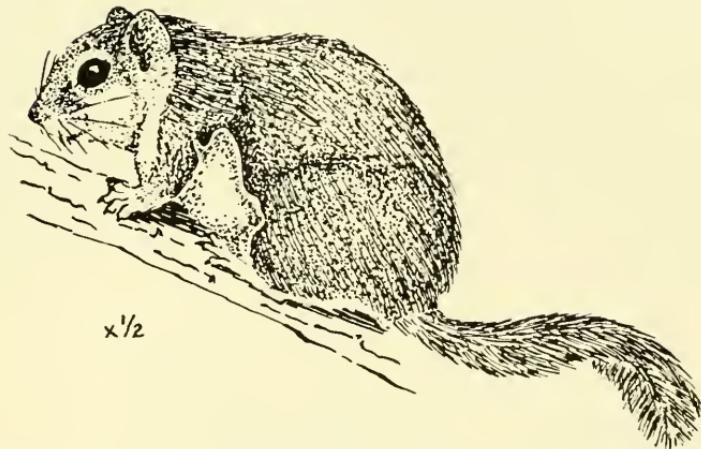
Distribution of *Tamias striatus*.
1. *T. s. griseus*. 2. *T. s. venustus*.

Onaga in Pottawatomie County and Independence, Montgomery County, are westernmost record stations of occurrence.

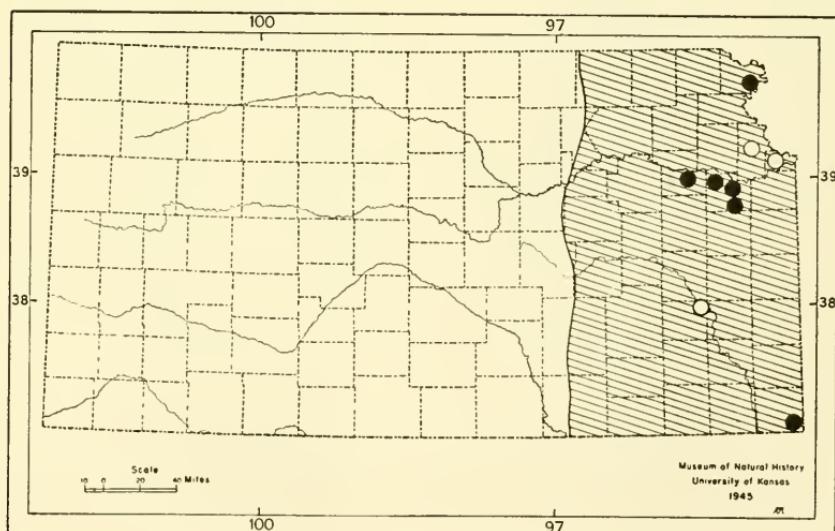
Description.—Total length, 239-261; tail, 90-100; hind foot, 35-38; ear from notch, 12-16.5. The color has been described essentially as follows by A. H. Howell (N. Amer. Fauna, 52:20, 1929): Top of head, dark facial stripes and anterior border of ear russet; light facial stripes pinkish buff; median dorsal bands smoke gray, more or less shaded on posterior back by tawny; rump hazel; dark dorsal stripes black, narrowly edged with hazel; light dorsal stripes creamy white; tail above, fuscous black overlaid with pale smoke gray; tail beneath, cinnamon or ochraceous tawny, bordered with fuscous black and edged with pale smoke gray; underparts of body creamy white. Winter pelage slightly paler. Features distinguishing this species from the ground squirrels are: bright colors, stripes on the head, five longitudinal black stripes from the shoulders to the rump, and four instead of five check-teeth on each side of the upper jaw.

There are two subspecies in Kansas: *Tamias striatus griseus* Mearns (Bull. Amer. Mus. Nat. Hist., 3:231, June 5, 1891) with type locality at Fort Snelling, Hennepin County, Minnesota, occurs in the northern half of eastern Kansas, and *Tamias striatus venustus* Bangs (Proc. Biol. Soc. Washington, 10:137, December 28, 1896) with type locality, at Stilwell, Adair County, Oklahoma, occurs in the southern half of eastern Kansas.

Genus *Glaucomys* Thomas
Southern Flying Squirrel
Glaucomys volans (Linnaeus)



The flying squirrel glides with outstretched membranes from one tree to the base of another, rarely descends to the ground, does not hibernate, stores nuts and seeds, eats these in winter, commonly has 4 young, and makes a good pet. Tapping on tree trunks having woodpecker holes, it is said, causes flying squirrels to show themselves; by this means I have several times dislodged angry wasps but never yet a flying squirrel.





This species is confined to the timber of the eastern fourth of the State. Shawnee County (Topeka) and Woodson County are the two westernmost record stations of occurrence.

Description.—Total length, 218-240; tail, 78-103; hind foot, 27-33; greatest length of skull, 33.8-35.6; zygomatic breadth, 20.1-22.2. Upper parts drab to pinkish cinnamon; underparts white with a creamy tinge; tail flattened (dorsoventrally); forelimbs and hind limbs connected by a broad fold of skin extending from wrists to ankles; palms with five tubercles (3 at bases of fingers, one at base of rudimentary thumb and one, opposite latter, on outside of wrist); soles with four tubercles as bases of toes. Mammae: pectoral $\frac{1}{4}$, abdominal $\frac{2}{2}$, inguinal $\frac{1}{4} = 8$. Dentition: i. $\frac{1}{1}$; c. $\frac{0}{0}$; p. $\frac{2}{2}$; m. $\frac{3}{3} = 22$. Diameter of opening of ear (external auditory meatus) in skull no less than length of occlusal surfaces of $2\frac{1}{2}$ upper molars.

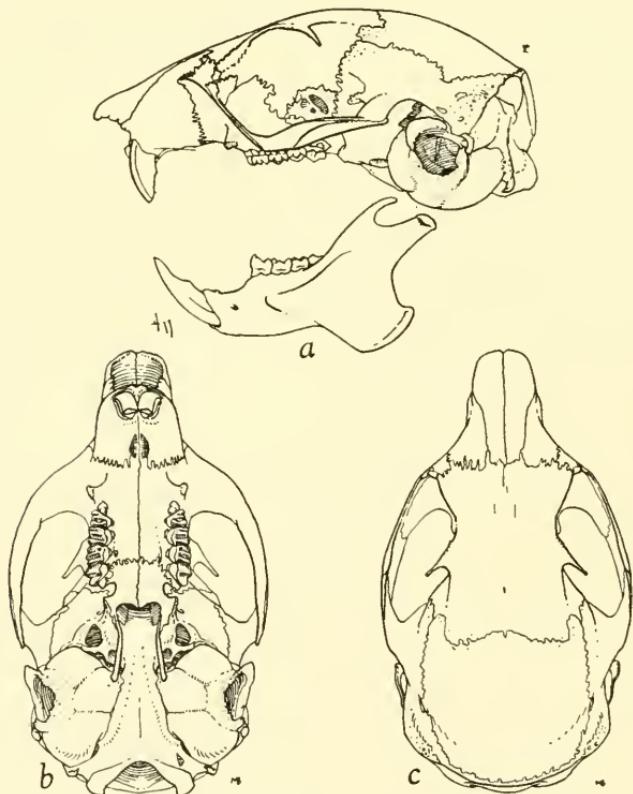


FIG. 24. Skull and left lower jaw of Southern Flying Squirrel, *Glaucomys volans volans* (Linnaeus), 4 mi. SE Bergman, Boone Co., Arkansas, ♀, No. 95369 MVZ, $\times \frac{1}{2}$.

In Kansas there is only the one subspecies, *Glaucomys volans volans*, named by Linnaeus (*Systema Naturae*, 1:63) in 1758 from Virginia.

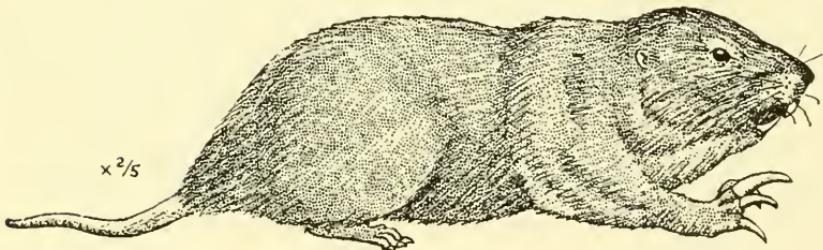
Family Geomyidae

KEY TO POCKET GOPHERS

1. Front surface of incisor tooth with two longitudinal grooves (one groove near middle and shallower groove near inner border); first and second upper molars with plate of enamel on posterior side Plains Pocket Gopher, page 103
- 1'. Front surface of incisor tooth with one longitudinal groove (it is near middle of anterior surface and there is no second groove near inner border); first and second upper molars lacking plate of enamel on posterior side (not yet certainly known from the modern fauna of Kansas) Chestnut Pocket Gopher, page 246

Genus *Geomys* Rafinesque

Plains Pocket Gopher

Geomys bursarius (Shaw)

In structure the Plains Pocket Gopher is only slightly less adapted to a fossorial existence than is the Eastern Mole in the account of which a comparison is made of the burrows of these two kinds of mammals.

The Plains Pocket Gopher digs its burrows mostly in search of food and pushes the excavated soil to the surface through inclined tunnels. The food is vegetable material, principally rootstocks and tubers but some vegetation that grows above-ground is eaten around the mouths of burrows through which loose earth is expelled. In obtaining the above-ground parts of plants the pocket gopher seems instinctively to avoid fully exposing itself for it ventures only as far from the mouth of its burrow as it can reach while keeping its tail and hind legs in the burrow. Even so, many pocket gophers are snatched up and eaten by owls, especially the Great-horned Owl. The Gopher Snake, often referred to as Bull Snake, is an important enemy of the Plains Pocket Gopher.

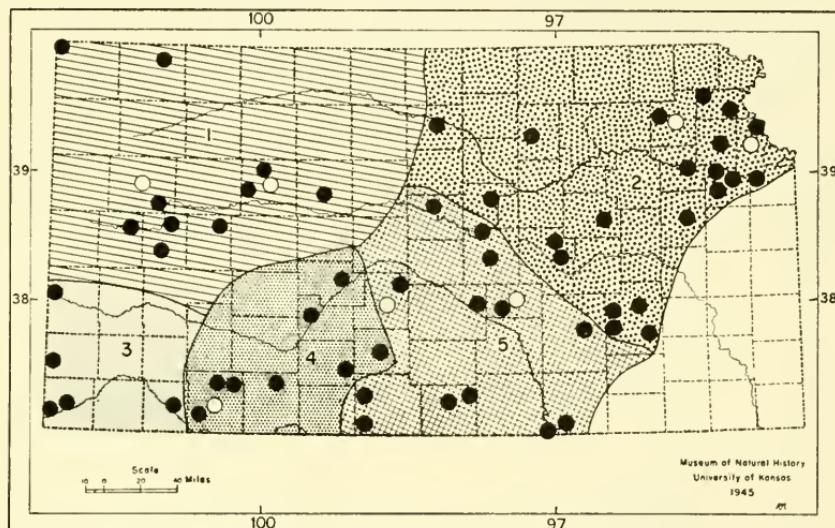
The fur-lined cheek pouches, contrary to popular belief, are not used at all in transporting soil but instead are used for carrying food that is stored in side tunnels or galleries connected with the main tunnel.

The fondness of pocket gophers for the tubers and enlarged roots of plants makes this rodent a nuisance and in places a serious pest because of the damage that the gopher does to certain of man's crops. Under such circumstances the farmer or gardener is justified in eliminating the gophers. Everything considered, the best method of doing this is to use traps of the Macabee type.

On uncultivated land, however, the pocket gopher is thought to be highly beneficial. The humus content of the soil is increased by vegetation being buried beneath the mounds of earth thrown up by the pocket gopher, by cut pieces of vegetation that are carried below ground and never eaten, and by the vegetation that is carried below ground and used in constructing nests. The excreta, all deposited below ground, also increases the humus content and fertility. Many of the mounds thrown out by pocket gophers are of earth from the layer of subsoil. Being thus exposed on the surface of the ground the subsoil material undergoes an increased rate of weathering and deepens the layer of topsoil. The gopher burrows are one means by which air, water and contained solvents are carried underground. The loosening of the soil by pocket gophers counteracts the packing effect on pasture lands of hooved animals. When pastures are overgrazed the grasses are partly replaced by weeds with large roots. These large roots are one of the special adaptations permitting these plants to live under adverse conditions. These large roots constitute an abundant food supply for pocket gophers which thrive and multiply. The action of the pocket gophers in "plowing" the soil and actually destroying the weeds hastens the return of grass if the overgrazing is controlled. With the return of the grass the pocket gophers decrease or disappear because of an unsuitable food supply. In the long run, therefore, the activities of pocket gophers increase the amount of grass-forage for livestock. On grass lands a dense population of pocket gophers is associated with overgrazing and with weeds and both the gophers and the weeds are symptoms, rarely causes, of a shortage of grass; the cause ordinarily is overgrazing. Reducing the number of livestock and increasing the fertility of the soil cause the weeds and therefore the pocket gophers to disappear.

In the light of what has been said above it would be expected that the bounty system of controlling pocket gophers would be ineffective and also expensive. Such is the case. Details on the ineffectiveness and expensiveness of this system in Kansas are summarized by Cockrum on pages 138-140 of "Mammals of Kansas" (Univ. Kansas Publ., Mus. Nat. Hist., vol. 7, no. 1, August 25, 1952).

The pocket gopher in Kansas has but one litter of young per year. The young are born in March or April and range in number from one to six; four is the usual number.



Distribution of *Geomys bursarius*. 1. *G. b. lutescens*.
2. *G. b. majusculus*. 3. *G. b. jugosicularis*. 4. *G. b. industrius*. 5. *G. b. major*.

The Plains Pocket Gopher occurs throughout all of the State except in the southeastern counties. Marginal record stations in that direction are: One mi. W Desoto, Johnson Co.; 10 mi. SW Lawrence, Douglas Co.; 3 mi. N Lyndon, Osage Co.; 8½ mi. SW Toronto, Greenwood Co.; and in Cowley County, at three places: 3½ mi. E, 3 mi. SE, and 3 mi. S of Arkansas City.

Occurrences shown on the map above and not accounted for by Cockrum (Univ. Kansas Publ., Mus. Nat. Hist., 7:137-143, August 25, 1952) are Marienthal in Wichita County and Topeka in Shawnee County. Specimens were collected at these places after Cockrum completed his work. On the map, specimens from Barber County are in the geographic range of *G. b. major* as Cockrum (*op. cit.*:143) intended they should be.

Description.—Total length, 215-357; tail, 59-95; hind foot, 28-37; basilar length of skull, 33.5-49.9; zygomatic breadth of skull, 24.6-38.0. Upper

parts Light Ochraceous Brown (in western Kansas) to Mummy Brown or Prout's Brown (in eastern Kansas); underparts Gray Drab or whitish (in western Kansas) to Mummy Brown with some whitish (in eastern Kansas); tail approximately one-third as long as head and body; forelimbs larger than hind limbs and provided with heavy claws; eyes and ears small; incisor teeth outside of mouth (lips meeting behind incisors); a large fur-lined cheek pouch on each side of face; two longitudinal grooves on anterior face of each upper incisor tooth.

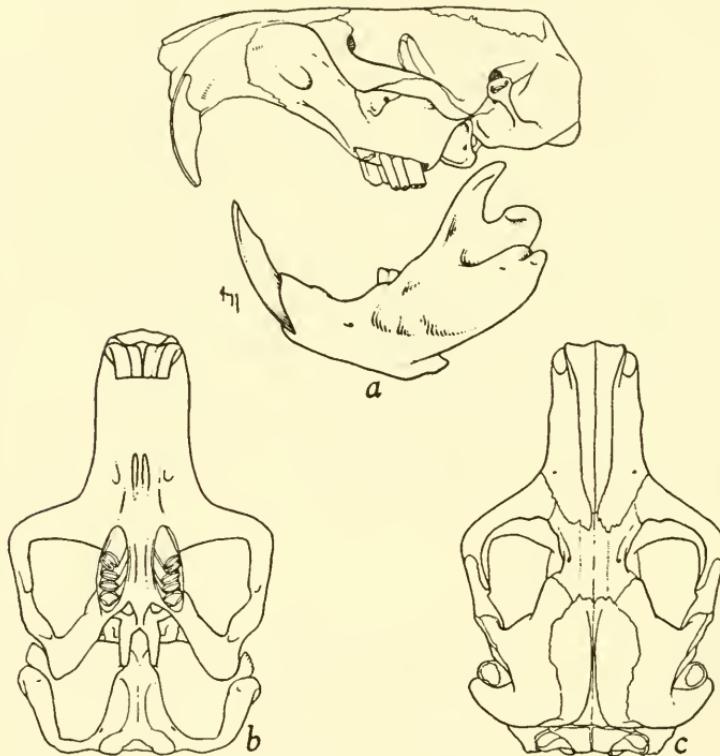


FIG. 25. Skull and left lower jaw of Plains Pocket Gopher, *Geomys bursarius industrius* Hall and Villa, 1½ mi. N Fowler, Meade Co., Kansas, ♂, No. 14083 KU (holotype), natural size.

As shown on the distribution map there are, in Kansas, five subspecies as follows: *Geomys bursarius lutescens* Merriam (N. Amer. Fauna, 4:51, October 8, 1890) with type locality in the sandhills along Bird Creek, Lincoln County, Nebraska; *Geomys bursarius majusculus* Swenk (Missouri Valley Fauna, 1:6, December 5, 1939) with type locality at Lincoln, Lancaster County Nebraska; *Geomys bursarius jugosicularis* Hooper (Occas. Papers Mus. Zool. Univ. Michigan, 420:1, June 28, 1940) with type locality at Lamar, Prowers County, Colorado; *Geomys bursarius industrius* Villa-R. and Hall (Univ. Kansas Publ., Mus. Nat. Hist., 1:226, November 29, 1947) with type locality one and one-half miles north of Fowler, Meade County, Kansas; and *Geomys bursarius major* Davis (Texas Agric. Exp. Station Bull. No. 590:32, October 23, 1940) with type locality 8 miles west of Clarendon, Donley Co., Texas.

FAMILY HETEROMYIDAE

KEY TO HETEROMYIDS

1. Soles of hind feet naked; greatest width of head less than distance between tip of nose and posterior angle of eye; interparietal bone more than $\frac{1}{4}$ greatest width of skull.
2. Total length less than 150; hind foot less than 19; occipitonasal length of skull less than 25; mastoids greatly developed and projecting beyond plane of the occiput; interparietal shorter than wide.
 3. Postauricular patches twice the length of the ears; interparietal breadth more than 4.1 Silky Pocket Mouse, page 109
 - 3'. Postauricular patches approximately same length as ears; interparietal breadth more than 4.1 Plains Pocket Mouse, page 107
- 2'. Total length more than 150; hind foot more than 19; occipitonasal length of skull more than 25; mastoids not so greatly developed (see fig. 28); interparietal no wider than long Coarse-haired Pocket Mouse, page 111
- 1'. Soles of hind feet densely haired; greatest width of head more than distance between tip of nose and posterior angle of eye; interparietal bone less than $\frac{1}{4}$ greatest width of skull Ord's Kangaroo Rat, page 113

Pocket Mice

Genus *Perognathus* Wied

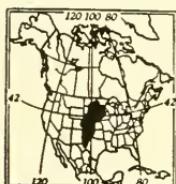
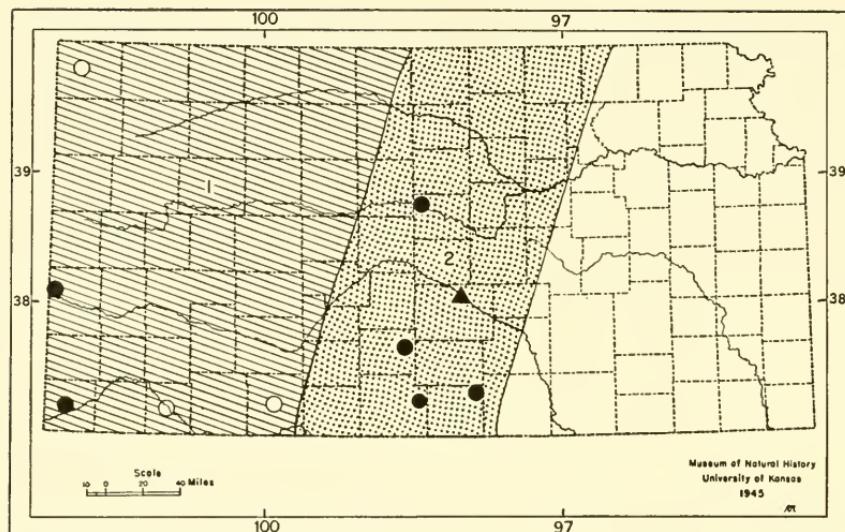
The cheek pouches are external and fur-lined as in pocket gophers and kangaroo rats. The tail is not tufted at the tip.

Plains Pocket Mouse

Perognathus flavescens Merriam



Silky quality of fur, pleasing color pattern, and docile nature make this mouse one of our most attractive small mammals. The description of color given below is of the western subspecies; the eastern subspecies is darker, being almost black on the back.



Distribution of *Perognathus flavescens*.
1. *P. f. flavescens*. 2. *P. f. cockrumi*.

Description.—Total length, 113-128; tail, 47-65; hind foot, 15-17; ear from notch, 6-7; occipitonasal length, 21.3-22.2; mastoidal breadth, 11.4-12.1. Upper parts Light Ochraceous Buff sparsely set with black hairs; postauricular patches and lateral line same color but without black; subauricular spots and underparts white; for comparison with *P. flavus* see account of that species.

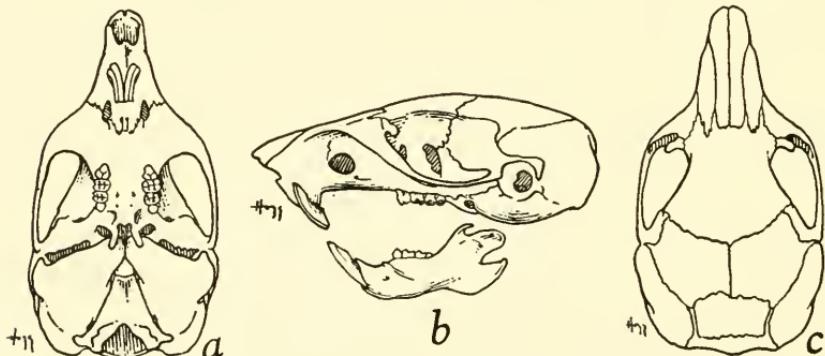
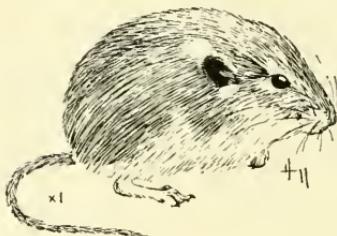


FIG. 26. Skull and left lower jaw of Plains Pocket Mouse, *Perognathus flavescens flavescens* Merriam, Kennedy, Cherry Co., Nebraska, ♀, No. 66883 USBS, $\times 2$.

Two subspecies are known from the State: *Perognathus flavescens flavescens* Merriam (N. Amer. Fauna, 1:11, October 25, 1899) has its type locality at Kennedy, Cherry County, Nebraska; *Perognathus flavescens cockrumi* Hall (Univ. Kansas Publ., Mus. Nat. Hist., 7:589, November 15, 1954) has its type locality at a point 4½ mi. NE Danville, Harper County, Kansas.

Silky Pocket Mouse
Perognathus flavus Baird



Seeds are the principal food of the Silky Pocket Mouse. The seeds are shelled and in many instances only the inner parts of the seeds are eaten as evidenced by the colorless contents of the stomachs of the mice. They are preyed upon by owls and several of the carnivorous mammals. Few if any are captured by hawks because the hawks are active only by day and the Silky Pocket Mouse is a nocturnal mammal. In some areas, and perhaps throughout its range, this mouse closes its burrow when inside. This is done by pushing a plug of sand up near the entrance, thus sealing the mouse off from outside enemies. In sandy areas where the wind blows fine particles of soil along the ground, even the mouth of the burrow is filled and a person who walks across the area in mid-day can find no trace of the mice, which are securely sealed in their burrows below ground. The temperature there changes relatively little and the Silky Pocket Mouse therefore escapes the heat of summer days.

Collectors of mammals have found it difficult to catch these mice. In the first place they are so small that the trap often springs over.

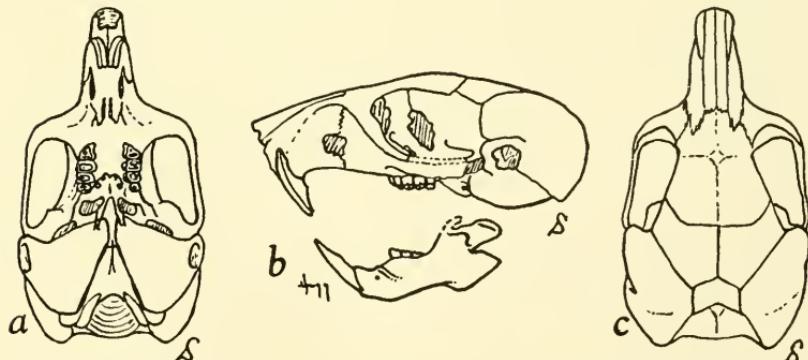
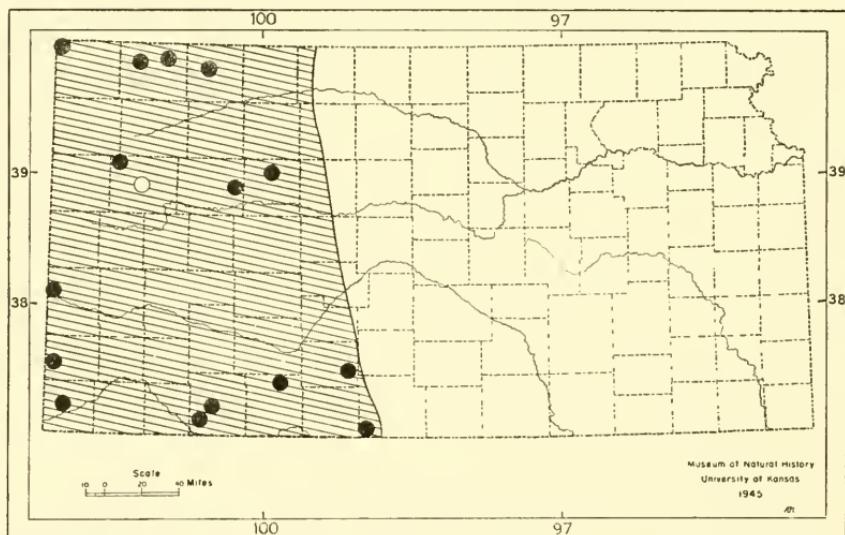


FIG. 27. Skull and left lower jaw of Silky Pocket Mouse, *Perognathus flavus flavus* Baird, 23 mi. (by road) NW St. Francis, Cheyenne Co., Kansas, ♀, No. 12092 KU, $\times 2$.

instead of on, one and if caught at all it usually is by the tail. Sometimes this breaks off and the mouse escapes. At certain seasons this species is not attracted in the least to the bait that the zoologist uses and the mice therefore do not even come to the traps that have been set for them. In one instance when the bait was unattractive to another species of pocket mouse we captured a few individuals at night by hand with the aid of a bright lantern. One mouse had the seeds of a wild plant in its cheek pouches. Search next day revealed the source of these seeds and they were hopefully used on the traps as bait. The mice, however, seemed to prefer seeds that they picked themselves; anyhow none was caught in the traps.



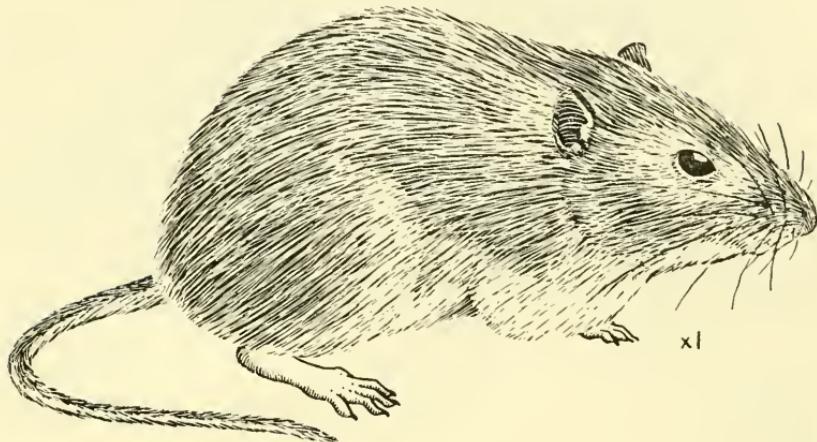
The easternmost record stations of occurrence now known are Wakeeney in Trego County, and 4 mi. S and $\frac{1}{2}$ mi. W Actna in Barber County.

Description.—Total length, 104-126; tail, 44-57; hind foot, 16-17; ear from notch, 6-8; occipitonasal length of skull, 20.6-22.8; mastoidal breadth, 12.0-12.1. Upper parts between Pinkish Buff and Cinnamon-Buff sparsely set with black hairs; postauricular spots near Pinkish Buff; subauricular spots and underparts white; from *Perognathus flavescens*, the Baird Pocket Mouse differs in longer postauricular patches (twice as long instead of same length as ear); narrower interparietal bone (more instead of less than 4.1 mm.); and more inflated auditory bullae which extend behind remainder of skull instead of extending backward only to the posterior margin of the skull.

Perognathus flavus bunker is the only subspecies in Kansas and was named by Cockrum (Univ. Kansas Publ., Mus. Nat. Hist., 5:205, December 15, 1951) with type locality one mile east of Coolidge, Hamilton County, Kansas.



Coarse-haired Pocket Mouse

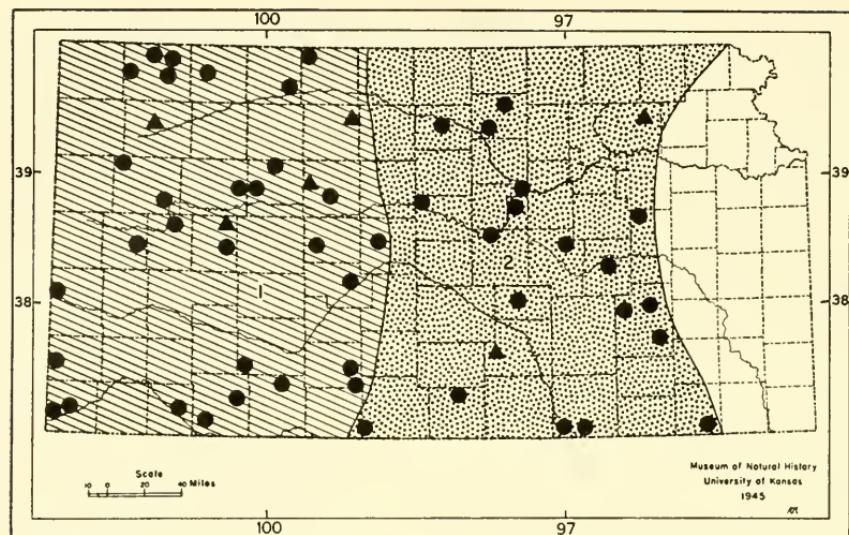
Perognathus hispidus Baird

Coarse-haired Pocket Mice are said to make their burrows in the open in ground that is almost bare, to store seeds, to eat plant materials and an occasional insect, and to have four to seven young in a litter.

The over-all length is eight to nine inches of which the tail makes up three to four and a half inches. The upper parts are ashy to dark ochraceous (some shade of ochraceous buff lined with black) including large hairs that make the pelage harsh to the touch. Low down on each side there is a lateral line of light ochraceous buff to ochraceous buff separating the darker upper parts from the white underparts.

The species shuns timbered areas and brushy areas, preferring country that originally was prairie and in fact the prairie itself. This species ranges much farther east in the State than either of the other two kinds of pocket mice that occur in Kansas. Careful search at the correct seasons (spring and summer) in remaining areas of prairie may disclose that this mouse lives farther east than any of the places where it so far has been taken.

This mouse is never found active above-ground in winter and the presumption is that it hibernates. Whether it hibernates all winter or awakens at intervals is unknown. Probably it does awaken at intervals and eat some of the stored seeds. The two fur-lined cheek pouches, one on either side of the face, are used to transport the seeds to their places of storage in the burrows.



Distribution of *Perognathus hispidus*.
1. *P. h. paradoxus*. 2. *P. h. spilotus*.

Easternmost record stations of occurrence are: Onaga, Pottawatomie Co.; 2 mi. S Chalk, Lyon Co.; Coffeyville, Montgomery Co. The only previously unreported record-station of occurrence shown on the distribution map above is Marienthal in Wichita County.

Description.—Total length, 190-235; tail, 71-113; hind foot, 25-27; ear from notch, 11-13; occipitonasal length, 29.2-33.9; mastoidal breadth, 14.9-17.4. For description of color see large type on preceding page. Postauricular spots and subauricular spots are inconspicuous or wanting.

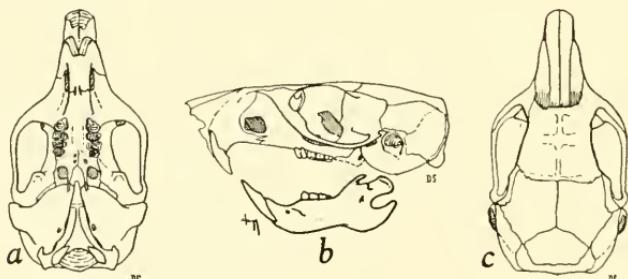
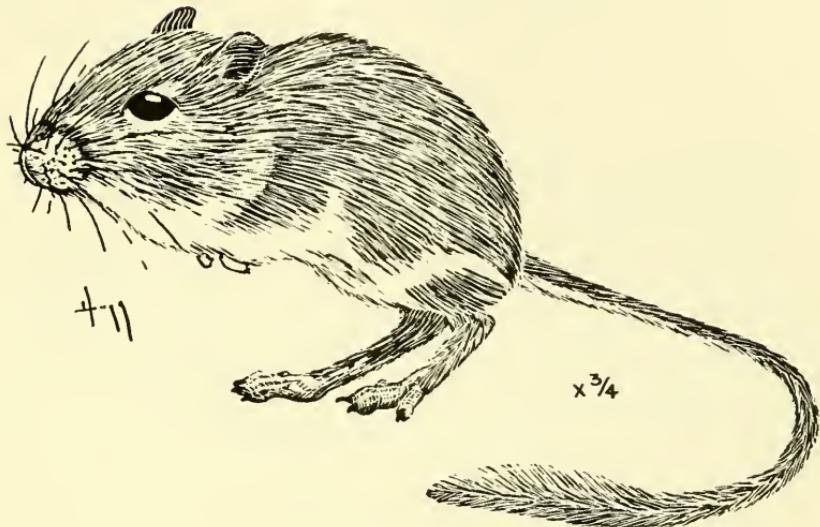


FIG. 28. Skull and left lower jaw of Coarse-haired Pocket Mouse, *Perognathus hispidus paradoxus* Merriam, 6 mi. S Atwood, Rawlins Co., Kansas, ♂, No. 35092 KU, natural size.

There are two subspecies in Kansas: *Perognathus hispidus paradoxus* Merriam (N. Amer. Fauna, 1:24, October 25, 1889) with type locality at Banner, Trego County, Kansas; and *Perognathus hispidus spilotus* Merriam (N. Amer. Fauna, 1:25, October 25, 1889) with type locality at Gainesville, Texas.

Genus *Dipodomys* Gray

Ord's Kangaroo Rat

Dipodomys ordii Woodhouse

Ord's Kangaroo Rat is confined to sandy soils, digs its own burrows, eats mostly leaves and seeds, and when hurrying travels on only the hind feet, leaping with both of them at the same time. In speedy locomotion no part of the long tail touches the ground but the tail is an important balancing organ, as also are the large auditory bullae. Trails 40 feet or more long extend from some burrows to feeding places. There are up to five young in a litter.

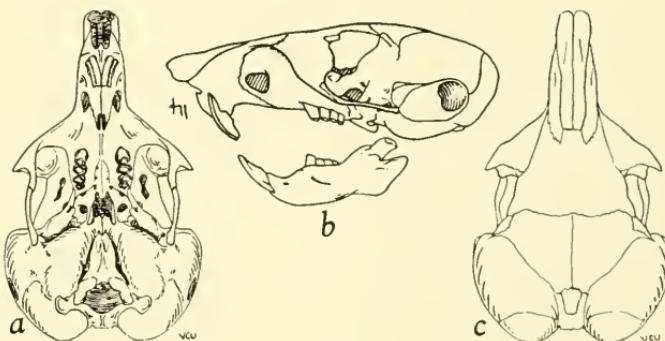
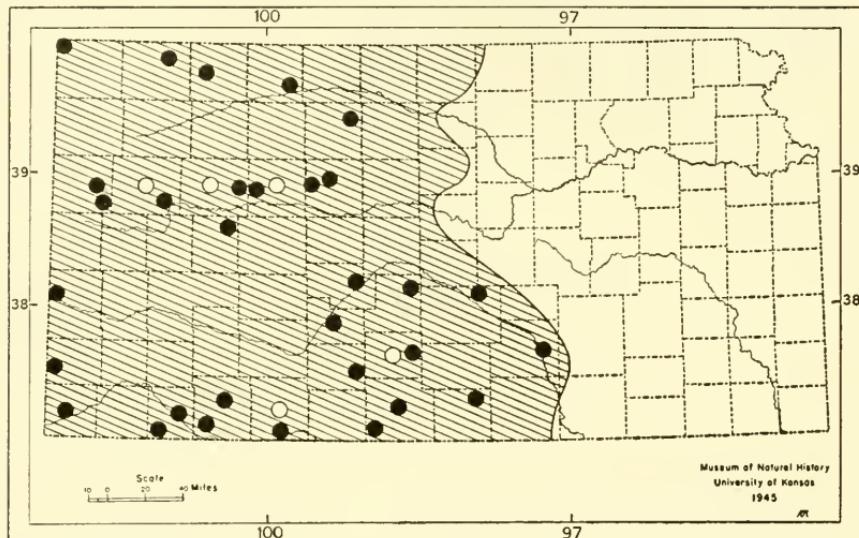


FIG. 29. Skull and left lower jaw of Ord's Kangaroo Rat, *Dipodomys ordii richardsoni* (J. A. Allen), 1 mi. S Lamar, Prowers Co., Colorado, ♀, No. 15995 KU, natural size.

Kangaroo rats can live without drinking. They conserve metabolic water by resorbing it in the kidneys and walls of the bladder. Being nocturnal, they are abroad only when the rate of evaporation is at a minimum; during the day they sleep curled up in an underground chamber, which is sealed off from the outside air by an underground plug of moist sand and hence the moisture that is exhaled is in part regained at the following inhalation.



The eastermost record station of occurrence is Wichita, Sedgwick County.

Description.—Total length, 243-256; tail, 133-136; hind foot, 40-42; ear from notch, 11-13; greatest length of skull, 39.4-41.8; greatest breadth across auditory bullae, 24.0-25.5. Upper parts Cinnamon Buff, purest on sides and flanks; back suffused with black; entire ventral surface, dorsal faces of hind feet, supraorbital and postauricular spots, forelimbs, hip stripes, lateral stripes of tail and entire base of tail pure white; arietiform markings, pinnae of ears, plantar surfaces of hind feet, dorsal and ventral stripes of tail blackish; in many specimens, ventral stripe of tail not extending to tip of pencil. Small ears, large eyes, silky texture of pelage, exceptionally long hind feet and hind legs, and long tail (longer than head and body) with well-developed brush of hairs on the tip are conspicuous characters. The skull is notable for tremendously enlarged auditory bullae, which are hollow instead of cancellous (of spongelike structure) as in pocket mice; the anterior face of each upper incisor tooth has a longitudinal groove; there are four cheek-teeth on each side of both the upper and lower jaw.

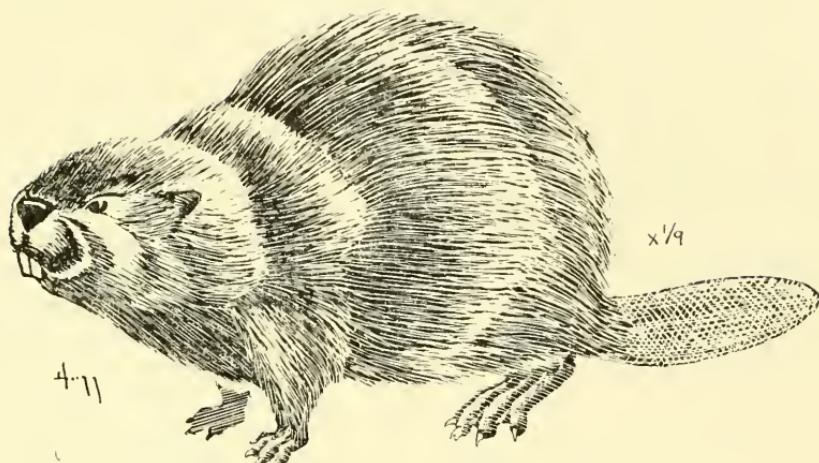
Dipodomys ordii richardsoni is the only subspecies in Kansas and it was named by J. A. Allen (Bull. Amer. Mus. Nat. Hist., 3:277, June 30, 1891) with type locality probably in Harper County, Oklahoma.



FAMILY CASTORIDAE

Genus *Castor* Linnaeus

Beaver

Castor canadensis Kuhl

Originally the Beaver lived throughout Kansas wherever there was both water and timber. Today it occupies essentially the same parts of the state as it did when White Man first arrived. Probably the largest numbers were taken before 1860. Between 1880 and 1912 so many of those remaining were taken by fur trappers that the animal was almost exterminated. Then the enactment of laws protecting the Beaver permitted its increase. It still has not reached its original level of abundance.

The large incisor teeth are effectively used in cutting woody plants including large trees. The inner layer of bark, along with twigs, makes up the food of the Beaver and the alternating layers of dentine and enamel on the grinding surfaces of the cheek-teeth are efficient in grinding the tough plant tissue into shreds that can be digested. Many of the other noteworthy structural features mentioned in the description below are adaptations fitting the Beaver for a life in the water. The dense fur, short valvular ear, webbed hind feet and flattened tail are adaptations of this nature.

Beavers can live for some time, perhaps for several days, away from water but they never do so in the wild state. If the water disappears where they live they migrate to a place where there is some. To Beavers, water means, for one thing, safety. At first hint

of danger they dive into it and out of sight. Entrances to their homes, whether these be burrows in banks of streams, ponds or lakes, or houses made of sticks and mud, are under water and thus are closed to terrestrial enemies. Most of our Beavers in Kansas are bank Beavers; that is to say, they live in burrows in banks instead of in houses. Not all do so, however. To provide and maintain a depth of water sufficient for the needs just mentioned, the Beavers in small streams, and sometimes in wide streams, work assiduously in cutting sticks and small poles and in dragging them to places where dams are to be constructed. A dam is faced with mud on the upstream side and raises the water level to the height required by the Beavers. In addition to providing refuge for the Beavers and covering for the entrances to their burrows or lodges, a pond serves as a waterway up and down which the Beavers travel and transport freshly cut limbs and other parts of the trees that they cut for food. Also the pond is a place in which the Beavers store food and move about below the ice in winter.

The formation of a Beaver pond in a small stream raises the water level in the stream and also in the near-by ground. As a result certain trees within the area affected die; limbs soon break and fall from the dead trunks and allow the entrance of moisture and fungi that hasten the enlargement of cavities so formed. Wood-peckers drill other holes in the dead trunks. These hollows provide essential nesting sites for tree swallows, crested flycatchers, blue-birds, titmice, wood ducks and other kinds of birds. Wood-boring insects multiply and provide food attractive to several birds and other animals. Because of the higher water table and formation of swampy land, cottonwoods and willows spring up in place of, and farther back than, those that died. A variety of other plants find a foothold and create a dense ground cover. In and about this area waterbirds, muskrats, mink and a host of other animals of widely different sorts find their preferred habitats created by the Beavers' work. Fish of several kinds find rearing ponds that are adapted to their special requirements. In the short period of ten to fifteen years, Beavers can tremendously alter the character of a habitat and the animal- and plant-life there.

The Beaver is the only mammal other than man that alters the natural environment in so drastic a fashion as to make over a major area of it in the course of providing a home for himself.

In some places where corn fields closely adjoin Beaver homes the animals knock down and destroy corn. Occasionally a fruit tree is cut down from those growing near a creek bank. A levee built

close to the river's edge may be burrowed into. Kansans complain about these losses now that Beavers are increasing under the protective laws that saved them from extinction. In the winter 1951-52 there was an open season permitting the trapping of beaver in the months of December and January when other fur-bearers are trapped. Persons interested in the natural resources of Kansas feared in 1952 that the open season would undo the benefits of

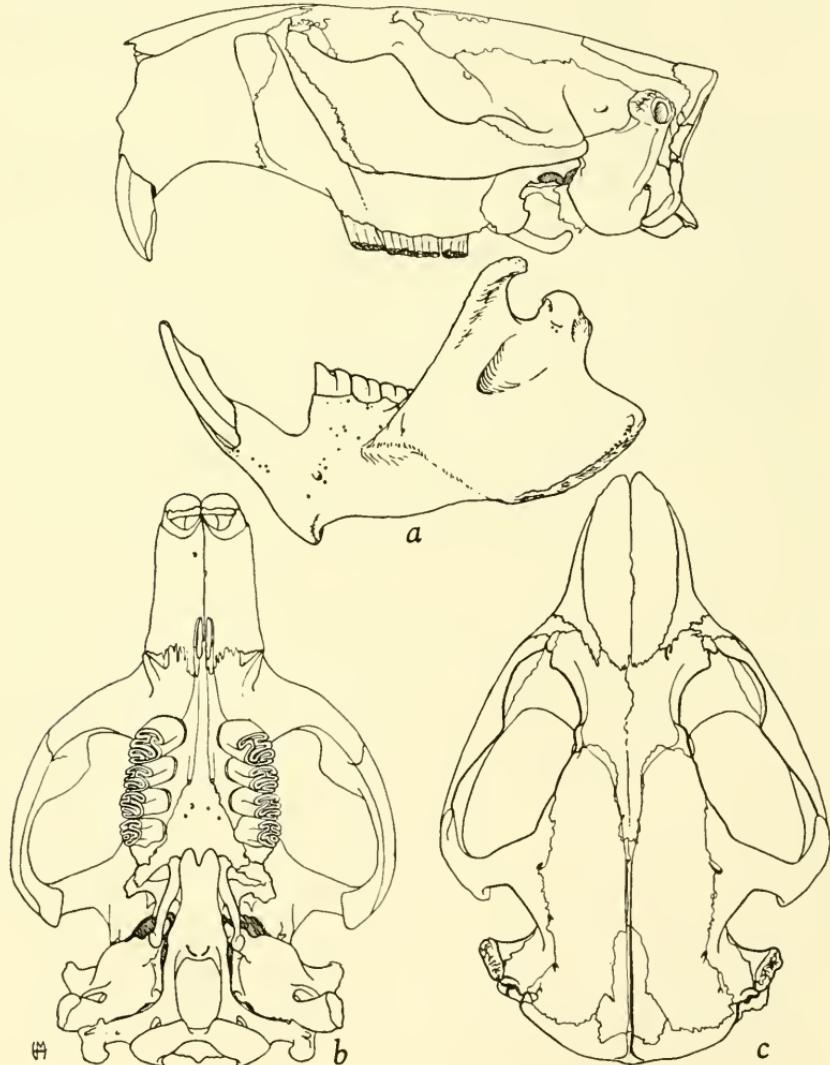


FIG. 30. Skull and left lower jaw of Beaver, *Castor canadensis* [subspecies *repentinus* Goldman], Colorado River $\frac{1}{2}$ mi. N California-Nevada Monument, Clark Co., Nevada, ♀, No. 61670 MVZ, $\times \frac{1}{2}$.

forty years of protection by wiping out the Beaver in certain smaller streams. This had happened in some other states because it was possible to trap "every last" Beaver in a single trapping-season in a fairly large stream. Fortunately this did not happen in Kansas in 1952-53 because unusually heavy rains raised the streams, covered the traps and otherwise hampered the Beaver trappers.

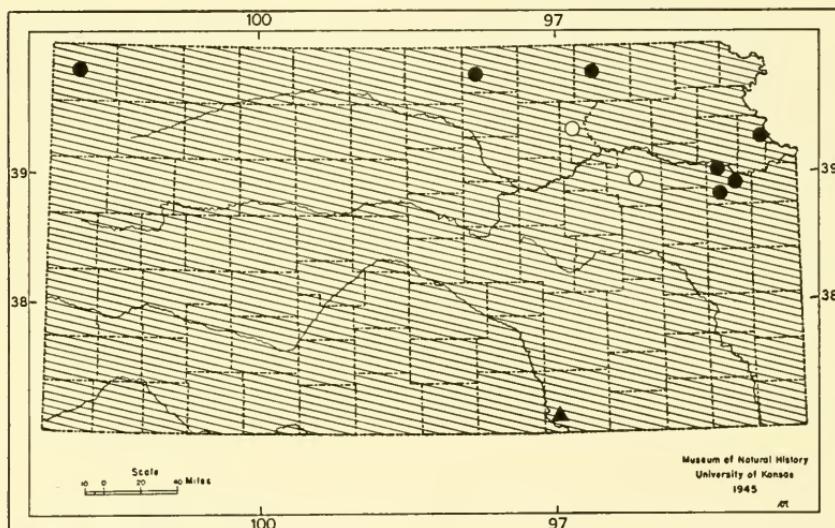
Hardly more than 3000 Beavers were caught. In the absence of advice or experience on how to prepare the skins many trappers improperly pelted the Beavers. This resulted in an average loss of between five and six dollars per pelt. Also, because Beavers do not become prime until late February or March, most of the pelts were unprime and this resulted in a further loss of five to six dollars per pelt. As a consequence the pelts brought less than \$10 each or only approximately \$30,000 in all instead of the \$63,000 expectable.

A system that has given good results in other states is this: A Game Protector, together with a landowner or the renter, examines the tracks and other sign of Beaver of a given area and estimates how many can be taken without seriously depleting the next year's breeding stock. When the number of Beaver to be trapped is decided upon, the farmer can elect to have a trapper employed by the Commission trap the Beaver and return half of the sales price for the pelts or the farmer can elect to trap the Beaver himself and keep all of the proceeds. In the latter event, supposing ten Beavers are to be trapped when the fur is prime, the Game Protector issues to the farmer (1) ten specially numbered metal seals and (2) a leaflet explaining how to remove flesh, stretch and cure the pelt so that it will command the maximum price. After a Beaver is skinned one of the numbered seals is attached to the pelt. The several states and Alaska co-operate in this system and the metal tag remains on the pelt until a late stage in the tanning process. Game wardens, state and federal, can easily recognize illegally taken pelts, prosecute the violators and so regulate the harvest of pelts thereby avoiding dangerous depletion of the Beaver population.

Ten pelts properly prepared in 1952 brought \$200 and in most of the preceding twenty years \$350 to \$400! Under this system the game wardens make friends for the Fish and Game Commission because the farmers feel that their sizable cash earnings from the sale of Beaver pelts result from wise action of the Commission—as is the fact; complaints to the Commission concerning damage

to crops decrease greatly or cease altogether because the farmers choose to overlook small amounts lost, say, in crops destroyed, when they expect to receive large amounts early in the next year from the sale of Beaver pelts; the breeding population of Beavers is enlarged in areas appropriate for them with the result that a natural resource is re-established and the actual wealth in the state is increased.

After a gestation period of approximately three months the Beaver has one litter each year of 1 to 8 young, usually 4 to 6. A beaver does not reach full size until three or more years old.



Description.—Total length, 967; tail, 410; hind foot, 174; ear from notch, 33. These measurements are of large females from eastern Kansas where some individuals weigh as much as 60 pounds. Condylabasal length of skull, 139.2; zygomatic breadth, 103. Fur dark brown. Other noteworthy features of this animal, the largest living North American rodent north of Central America, are as follows: underfur so dense as to be almost impervious to water; overhairs much longer than fur; neck and legs unusually short; ear so short as to be almost concealed in fur; ear opening capable of being closed at will; hind feet several times larger than forefeet and webbed; tail scaly and paddle shaped; front part of skull broad and deep; chiselike incisor teeth large; cheek-teeth long-crowned and grinding surface made up of alternating layers of enamel and dentine.

Castor canadensis missouriensis is the only subspecies in Kansas and was named by Bailey (Jour. Mammalogy, 1:32, November 28, 1919) with type locality on Apple Creek, 7 mi. E of Bismarck, Burleigh County, North Dakota.

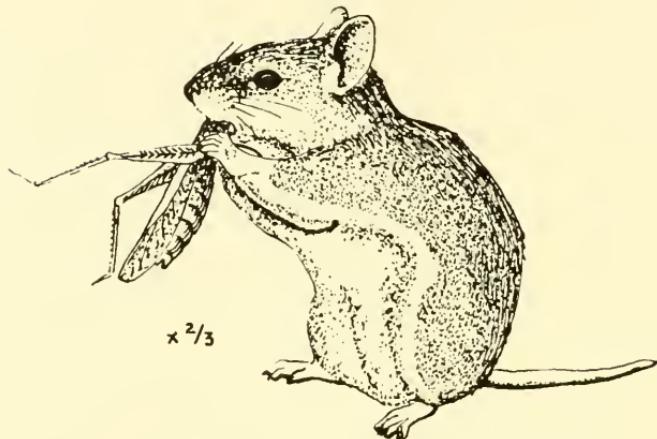
FAMILY CRICETIDAE

KEY TO CRICETIDS—NATIVE MICE AND RATS

1. Tail round (not laterally compressed into a rudder); no fringe of stiff hairs on toes of hind foot for swimming; length of skull less than 50.
 2. Cheek-teeth with cusps, no flat occlusal area composed of tracts of dentine surrounded by enamel.
 3. Cusps on cheek-teeth not flattened and not divided into S-shaped lophs; tooth-row shorter than 5; guard hairs not prominent and pelage smooth to the touch.
 4. Tail less than 60 per cent of length of head and body; coronoid process of mandible high (see page 122)
..... Northern Grasshopper Mouse, page 122
 - 4'. Tail more than 60 per cent of length of head and body; coronoid process of mandible low (see page 124).
 5. Upper incisors grooved on anterior face.
 6. Upper parts golden brownish; venter grayish white, usually washed with buff; length of tail more than 77. Fulvous Harvest Mouse, page 124
 - 6'. Upper parts grayish or brownish; venter never washed with buffy; length of tail less than 77.
 7. Width of stripe down top-side of tail more than $\frac{1}{4}$ circumference of tail; underparts of body grayish; mid-dorsal stripe on back faintly defined; tail longer than 65; length of skull more than 20.3; in unworn dentition, small accessory cusp evident on outer surface of first and second larger cusps Western Harvest Mouse, page 126
 - 7'. Width of stripe down top-side of tail no more than $\frac{1}{4}$ circumference of tail; underparts of body white; mid-dorsal stripe on back usually well defined; tail usually shorter than 65; length of skull less than 20.3; no accessory cusp on first lower molar between first and second larger cusps
..... Plains Harvest Mouse, page 128

- 5'. Upper incisors not grooved on anterior face.
8. Total length more than 225; skull shorter than 30; temporal ridges forming pronounced "beads" above orbits.....(may occur in Kansas) Rice Rat, page 246
- 8'. Total length less than 225; skull shorter than 30; temporal ridges not forming pronounced "beads" on sides of skull above orbits.
9. Hind foot longer than 23.5; ear longer than 18; skull longer than 26.8.....Brush Mouse, page 184
- 9'. Hind foot shorter than 23.5; ear shorter than 18; skull shorter than 26.8.
10. Tail sharply bicolored and usually shorter than 65; hind foot shorter than 21; skull usually shorter than 22.....Deer Mouse, page 130
- 10'. Tail faintly, if at all, bicolored and usually longer than 65; hind foot usually longer than 21; skull usually longer than 22
- Woods Mouse, page 132
- 3'. Cusps on cheek-teeth flattened and divided into S-shaped lophs; tooth-row longer than 5; guard hairs prominent and pelage rough to the touch
- Hispid Cotton Rat, page 136
- 2'. Cheek-teeth without cusps, flat occlusal area composed of tracts of dentine surrounded by enamel.
11. Total length more than 300; skull more than 35.
12. Color fulvous or rufous; length of incisive foramina less than 11
- Eastern Wood Rat, page 139
- 12'. Color gray above without rufous tinge; length of incisive foramina more than 11
- Gray Wood Rat, page 142
- 11'. Total length less than 300; skull less than 35.
13. Tail no longer than hind foot; upper incisors grooved on anterior face
- Southern Lemming-mouse, page 143
- 13'. Tail no less than 1½ times as long as hind foot; upper incisors smooth on anterior face.
14. Tail more than 25; pelage grayish ..Prairie Vole, page 148
- 14'. Tail less than 25; pelage chestnut....Pine Vole, page 151
- 1'. Tail laterally compressed into a rudder (not round); fringe of stiff hairs on toes of hind feet for swimming; length of skull more than 50
- Muskrat, page 145

Genus *Onychomys* Baird
 Northern Grasshopper Mouse
Onychomys leucogaster (Wied)



The Northern Grasshopper Mouse is nocturnal, seems not to hibernate, and subsists principally on insects. Approximately ninety per cent of the food is animal matter and almost eighty per cent is insects. Several of the kinds of insects eaten are agricultural pests and the grasshopper mice therefore are thought of as beneficial to man in his agricultural activity.

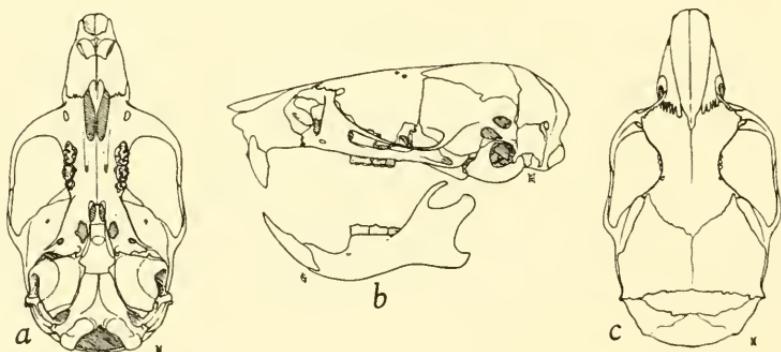
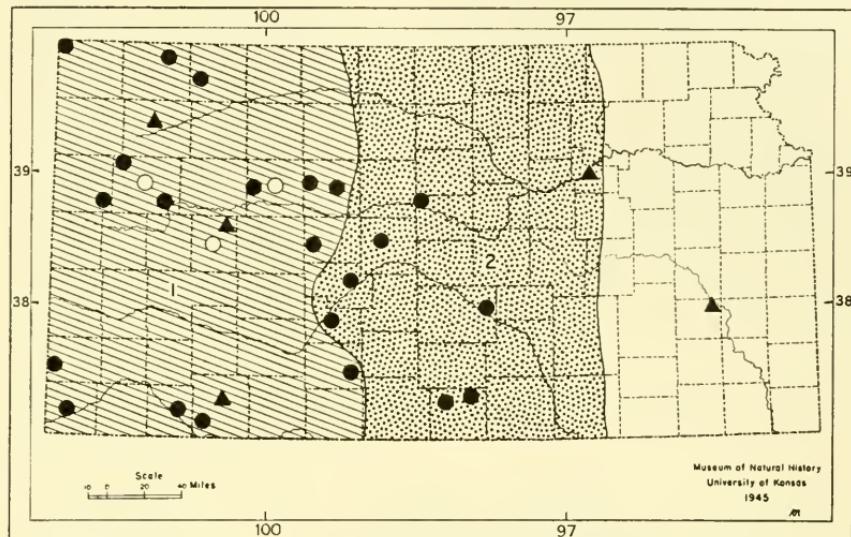


FIG. 31. Skull and left lower jaw of Northern Grasshopper Mouse, *Onychomys leucogaster* [subspecies *brevicaudus* Merriam], 16 mi. NE Iron Point, Humboldt Co., Nevada, ♂, No. 68276 MVZ, $\times 1\frac{1}{2}$.

The gestation period varies from 33 to 47 days in females that are lactating (giving milk) but seems to be no longer than 32 days

in non-lactating females. At birth the average weight of the young is between two and three grams which is approximately seven per cent of the weight of the mother. The eyes open on the fifteenth to the twentieth day. There are 2 to 6 young at a birth, 4 or 5 being the usual number.



Distribution of *Onychomys leucogaster*.
1. *O. l. arcticeps*. 2. *O. l. breviauritus*.

In Kansas the species has been reported (see map above) from as far east as Fort Riley in Geary County and Neosho Falls in Woodson County.

Description.—Total length, 138-157; tail, 39-51; hind foot, 21.5-23; ear from notch 15-19; greatest length of skull, 26.0-29.3; greatest breadth of braincase, 12.0-12.9. Upper parts (variable in color depending on age of animal, stage of molt and the subspecies) avellaneous, light drab, dull grayish brown or blackish brown, and some specimens having much pinkish buff; underparts white; tail brownish above; white below and in many specimens with white tip.

The Northern Grasshopper Mouse resembles mice of the genus *Peromyscus* but differs in several features of which the following are the more noteworthy: stouter-bodied, shorter-tailed, four instead of five tubercles on sole of hind foot, more wedge-shaped nasal bones, higher coronoid process on mandible of lower jaw, higher-crowned molar teeth.

There are two subspecies in Kansas. *Onychomys leucogaster arcticeps*, in the western third of the State, was named by Rhoads (Proc. Acad. Nat. Sci. Philadelphia, 1898, p. 194, May 3) with type locality at Clapham, Union County, New Mexico. *Onychomys leucogaster breviauritus*, in the central third of the State, was named by Hollister (Proc. Biol. Soc. Washington, 26:216, December 20, 1913) with type locality at Fort Reno, Oklahoma.

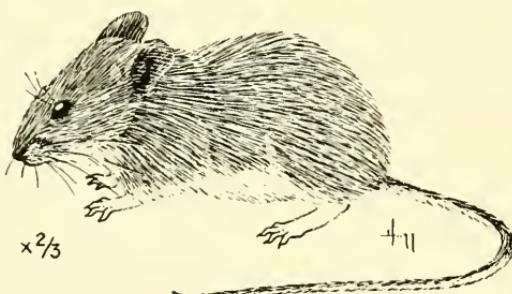
Genus *Reithrodontomys* Giglioli

Harvest Mice

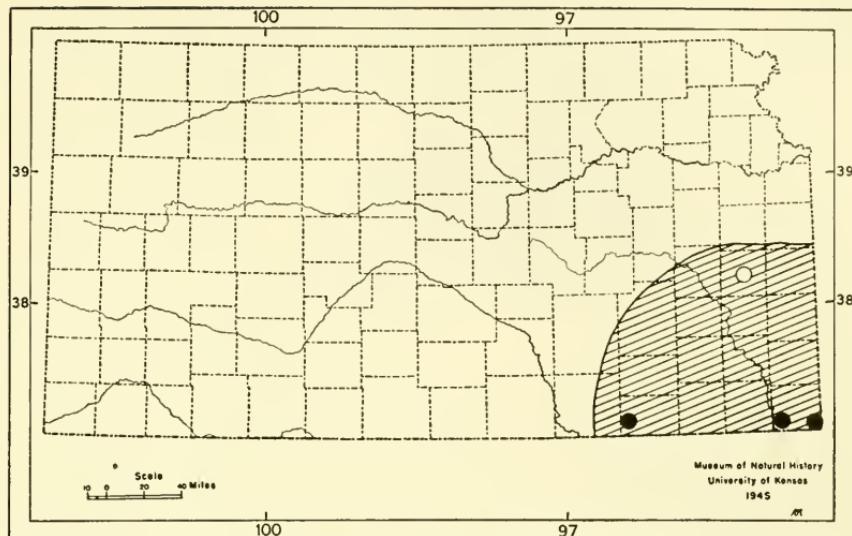
Three species occur in Kansas. Superficially they resemble their relatives of the Genus *Peromyscus*, the Deer Mouse and Woods Mouse, and by many persons are mistakenly identified as the young of these two species. The harvest mice, however, have relatively longer tails and the tail is more sparsely haired than in mice of the genus *Peromyscus* which are larger. A certain means of distinguishing the harvest mice is the longitudinal groove on the front of each of the two upper incisor teeth; in the white-footed mice (Genus *Peromyscus*) and grasshopper mice (Genus *Onychomys*) the incisor teeth lack the groove and are smooth on the anterior face. Harvest mice have three pairs of mammae; one pair is on the pectoral (chest) region and the other two pairs are on the inguinal (groin) region.

Fulvous Harvest Mouse

Reithrodontomys fulvescens J. A. Allen



The Fulvous Harvest Mouse has been taken in lowlands along streams where areas of grass alternated with areas of brush. Almost nothing else is known about the habits or habitat of this species in Kansas. In Louisiana, however, the nest, seldom larger than a baseball, is placed in tangled masses of rank marsh vegetation usually several feet above the ground and never on the ground. The nests are made of finely shredded leaves of marsh grasses and sedges and one nest ordinarily shelters a pair of mice. In nature the food was seeds and the tender succulent shoots of marsh grasses and sedges. In captivity, over a period of two weeks, one of these mice consumed, of a variety of vegetable matter, an average of 32 per cent of the animal's weight per day. Two young are reported for one female, but this number may be fewer than the average.



In Kansas, specimens have been saved from as far north as an unspecified locality in Anderson County and from as far west as a place $1\frac{1}{4}$ mi. SW Cedar Vale in Chautauqua County.

Description.—Total length, 154-165; tail, 83-89; hind foot, 19-22; ear from notch, 13-15; greatest length of skull, 20.4-23.0; zygomatic breadth, 10.7-11.4. Upper parts reddish brown, a mixture of Cinnamon of the cover hairs and Black of the guard hairs; ears and upper surface of tail Fuscous; underparts Light Pinkish Cinnamon. The golden brownish (instead of grayish or brownish) upper parts and long tail (more instead of less than 77 mm.) distinguish this species from the two other species of harvest mice found in Kansas.

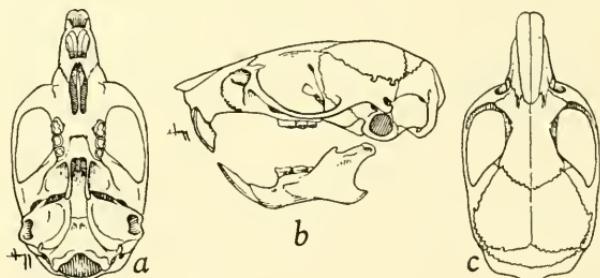
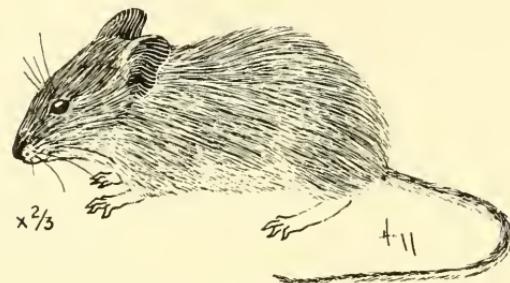


FIG. 32. Skull and left lower jaw of Fulvous Harvest Mouse, *Reithrodontomys fulvescens* [subspecies *intermedius* J. A. Allen], Brownsville, Cameron Co., Texas, ♂, No. 1920 KU, $\times 1\frac{1}{2}$.

Only one subspecies occurs in Kansas. It is *Reithrodontomys fulvescens aurantius* J. A. Allen (Bull. Amer. Mus. Nat. Hist., 7:137, May 21, 1895) with type locality at Lafayette, Lafayette Parish, Louisiana.

Western Harvest Mouse

Reithrodontomys megalotis (Baird)

This species thrives where there is dense vegetation, especially grass. Local abundance depends on a variety of vegetation that provides food at all seasons. Uncultivated fields, especially lightly or moderately grazed pastures, are favored. Seeds of grasses make up most of the food. Kinds of grasses having large seeds are preferred. On the University of Kansas Natural History Reservation my colleague, Dr. Henry S. Fitch, found the mice eating seeds of foxtail, switchgrass, Indian grass, false redtop, brome, and side-oats grama. In spring succulent stems are eaten and in summer many insects, especially grasshoppers.

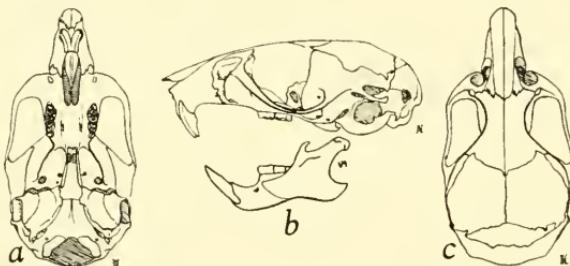
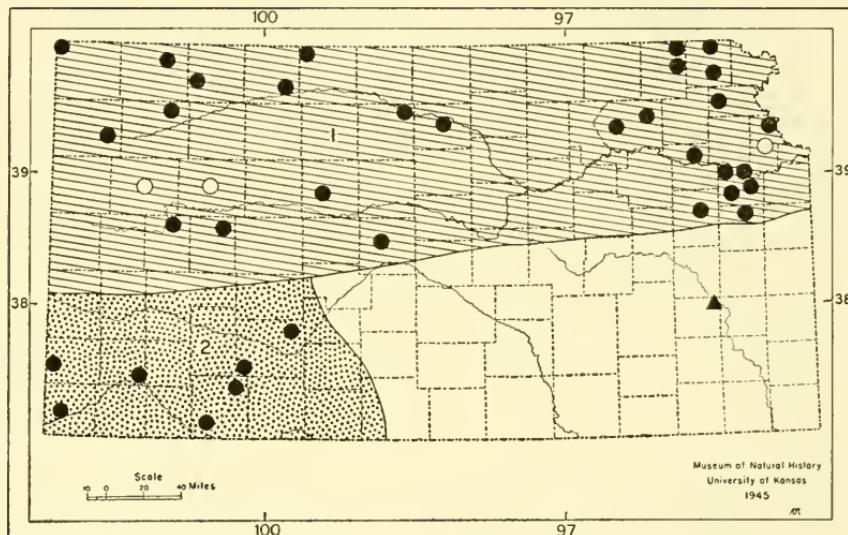


FIG. 33. Skull and left lower jaw of Western Harvest Mouse, *Reithrodontomys megalotis* [subspecies *megalotis* (Baird)] Crystal Spring, Lincoln Co., Nevada, ♂, No. 52998 MVZ, $\times 1\frac{1}{2}$.

These mice climb among grass stems; several, upon release from live traps, traveled many yards through the grass without coming to the ground. Young climb even before their eyes are open. The feet are efficient for catching and holding grass stems. Toes of the forefeet flex opposing the palm and grasping stems between. Stems are grasped between the fourth and fifth toes of the hind foot. Runways are made beneath grass and runways of meadow voles also are used.

Nests are approximately spherical and three to six inches in diameter. Typically there is an outer layer of finely shredded dry grass and an inner layer of wool, cotton, down from milkweed or thistle or other soft and fluffy material. In winter most nests are underground but in summer they are mostly on the ground surface and a few are above the surface, some as much as two feet.

There are two to five young in a litter; the average number is three and a half. One female living under natural conditions produced two litters with an interval of 23 days between.



Distribution of *Reithrodontomys megalotis*.
1. *R. m. dychei*. 2. *R. m. aztecus*.

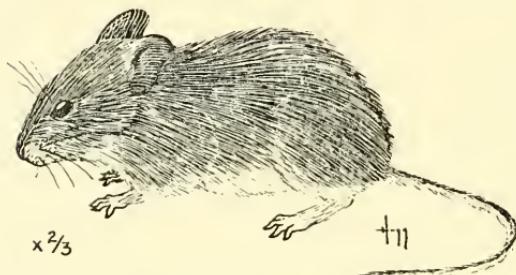


Available records suggest that this species occurs throughout the State except in the southeastern part. The outlying record station in that direction is Neosho Falls, Woodson County.

Description.—Total length, 118-156; tail, 55-77; hind foot, 14-20; ear from notch, 12-14; weight, 8.0-16.4 grams; greatest length of skull, 20.0-22.6; greatest breadth of braincase, 9.3-10.4. Upper parts grayish to brownish with moderately well defined mid-dorsal stripe of darker color; underparts grayish; width of dark stripe on top of tail one-fourth to one-third of diameter of tail. Differences useful in distinguishing this species from the Fulvous Harvest Mouse and the Plains Harvest Mouse are mentioned in the accounts of those species.

There are two subspecies in Kansas. *Reithrodontomys megalotis dychei* was named by J. A. Allen (Bull. Amer. Mus. Nat. Hist., 7:120, May 21, 1895) with type locality at Lawrence, Douglas County, Kansas. *Reithrodontomys megalotis aztecus* also was named by J. A. Allen (Bull. Amer. Mus. Nat. Hist., 5:79, April 28, 1893) with type locality at La Plata, New Mexico.

Plains Harvest Mouse

Reithrodontomys montanus (Baird)

The Plains Harvest Mouse seems to be less abundant than the Western Harvest Mouse and in eastern Kansas may occur only in native grass. In western Kansas the mouse seems to inhabit principally the areas of short grass and prickly pear cactus. Three, four and five are the numbers of embryos found in females.

This small mouse, among others, is one link in the food chain that begins with the soil that produces the grass that produces the seeds that this mouse eats. The mouse is eaten by the blueracer or the rat snake that is eaten by the hawk that dies, decays and contributes chemicals to the soil. So goes the cycle or food chain. Although small individually, the great numbers of mice make them tremendously important in the balance of nature. They are the principal food of many of the larger land-snakes, the carnivorous mammals,

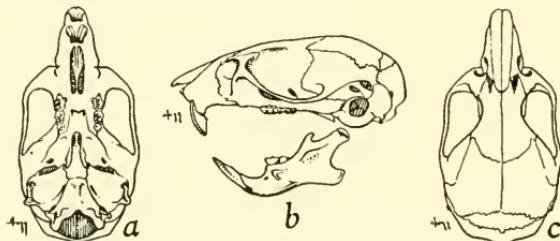
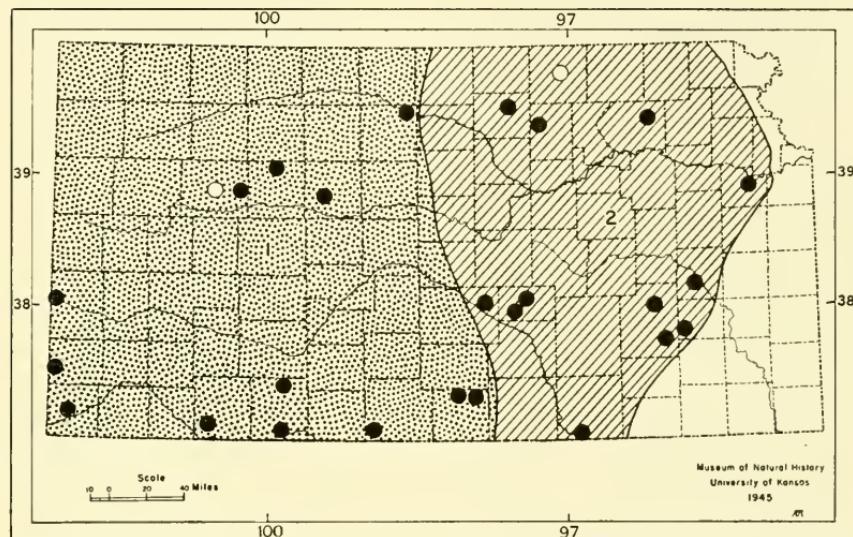


FIG. 34. Skull and left lower jaw of Plains Harvest Mouse, *Reithrodontomys montanus albescens* Cary, 2 mi. NE Runnymede, Harper Co., Kansas, ♂, 12685 KU, $\times 1\frac{1}{2}$.

and the hawks and owls. The dependence of these flesh eaters on the mice is so great that the flesh eaters actually become scarce after drought or some other factor unfavorable to the mice reduces the number of mice and thus deprives the flesh-eaters of food. Truly the mice are the staff of life for many other animals.

Like the Golden Harvest Mouse and Western Harvest Mouse, the Plains Harvest Mouse frequently is mistaken for the young of the Deer Mouse and Woods Mouse but unlike the two species last named has a groove down the front of each upper gnawing tooth. Among Kansas mice these grooves are shared with only pocket mice (having fur-lined cheek pouches) and the Southern Lemming-mouse.



Distribution of *Reithrodontomys montanus*.
1. *R. m. albescens*. 2. *R. m. griseus*.

Description.—Total length, 105-143; tail, 43-63; hind foot, 15-17; ear from notch, 12-15; greatest length of skull, 19.2-20.8; greatest breadth of braincase, 9.0-10.0. Upper parts grayish with well defined mid-dorsal stripe of darker color; underparts white; width of dark dorsal stripe on tail less than a fourth of diameter of tail. From the Western Harvest Mouse, the Plains Harvest Mouse differs in slightly smaller size, presence of a dark mid-dorsal stripe, white instead of grayish underparts, and a narrower dark stripe on the upper side of the tail.

The Plains Harvest Mouse occurs throughout the State except in the southeastern part and eastern tier of counties. Southeasternmost record stations of occurrence are Lawrence in Douglas Co., 2½ mi. S Burlington in Coffey Co., 2½ mi. N Toronto in Woodson Co., and 3 mi. SE Arkansas City in Cowley Co.

There are two subspecies in Kansas. *Reithrodontomys montanus albescens* of the western half of the State was named by Cary (Proc. Biol. Soc. Washington, 16:53, May 6, 1903) with type locality eighteen miles northwest of Kennedy, Cherry County, Nebraska. *Reithrodontomys montanus griseus* of the eastern part of the State was named by Bailey (N. Amer. Fauna, 25:106, October 24, 1905) with type locality at San Antonio, Bexar County, Texas.

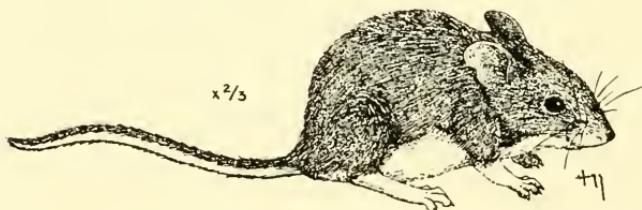
White-footed Mice

Genus *Peromyscus* Gloger

Three species occur in Kansas. These are the most abundant wild mice in the State. All have white underparts, lack grooves on the front of the upper incisor teeth, and have relatively long tails which amount to two-fifths to one-half of the total length. More than half of the food is thought to be plant material but all of the species are known to eat animal matter; insects make up a major share of the animal matter consumed.

Deer Mouse

Peromyscus maniculatus (Wagner)



The Deer Mouse inhabits grasslands whereas the Woods Mouse lives in the timber. For nesting sites the Deer Mouse uses the burrows of other mice, crevices in old logs and other kinds of cover. Also it is said to use shallow burrows that it, itself, digs. Nests ordinarily are made of grass.

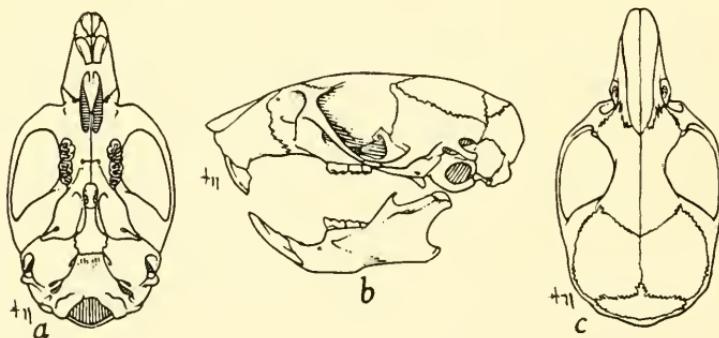
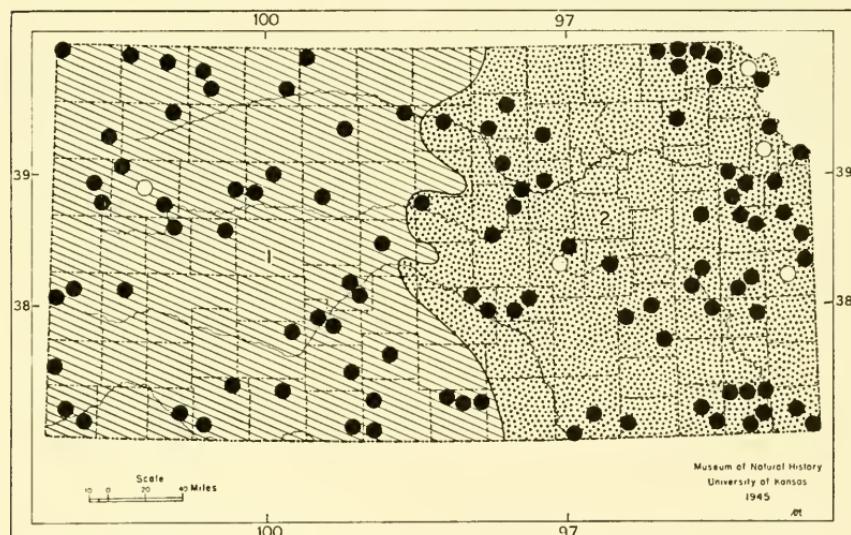


FIG. 35. Skull and left lower jaw of Deer Mouse, *Peromyscus maniculatus bairdii* (Hoy and Kennicott) 8 1/10 mi. E Arkansas City, Cowley Co., Kansas, No. 39268 KU, ♀, $\times 1\frac{1}{2}$.

Deer mice are active throughout the year and only a few persons have suspected that they hibernate. Walter E. Howard in Michigan found that in cold weather mice of this species would "aggre-

gate" below ground in groups of a few to more than a dozen (Journal of Mammalogy, 32:307, August 23, 1951) and that many of these were lethargic or torpid. When the animals were torpid "the eyes were closed. . . . The rate of respiration, heart beat, and body temperature all were markedly decreased; but they (the mice) survived as indicated by later recaptures."

Individuals born in captivity have lived eight years, and as many as ten litters of young have been born to one female in a year. There are from one to nine young in a litter. The gestation period is 22-27 days in non-lactating females and as much as 35 days in some lactating females. At birth the young are pink (unpigmented). The eyes open on the 12th to the 17th day.



Distribution of *Peromyscus maniculatus*.
1. *P. m. nebrascensis*. 2. *P. m. bairdii*.

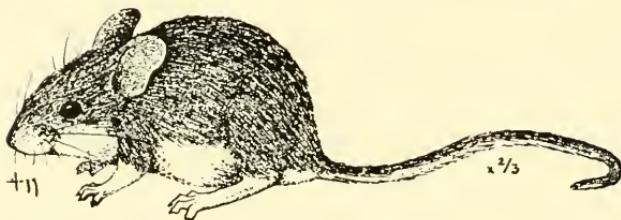


Description.—Total length, 127-153; tail, 49-64; hind foot, 18-21; ear from notch, 13-17; basilar length of skull, 17.1-21.1; zygomatic breadth, 11.3-13.2. Upper parts rich russet or warm brown with a black mid-dorsal stripe (in the subspecies *P. m. bairdii* of eastern part of State); tail sharply bicolor, underparts white. This is the smallest of the three species of white-footed mice in Kansas and differs from the Brush Mouse in smaller size, especially of the ears, and from the Woods Mouse in shorter hind foot, and shorter, hairier, more sharply bicolored tail.

Two subspecies occur in Kansas. *Peromyscus maniculatus nebrascensis*, in the western half of the State, was named by Coues (Monograph of North American Rodentia, p. 77, 1877) with type locality on Deer Creek in western Nebraska. *Peromyscus maniculatus bairdii*, in the eastern part of the State, was named by Hoy and Kennicott (in Kennicott, Agricultural Report, U. S. Patent Office, p. 92, 1856), with type locality at Bloomington, Illinois.

Woods Mouse

Peromyscus leucopus (Rafinesque)



The Woods Mouse has not yet been recorded in the central three tiers of counties of the western part of the State.

As the name implies, this species lives in the woods or where there is some timber or brush. Nest sites far more often are in trees than on the ground; cracks and hollows in trees and spaces in stumps are favorite places for nests. The nests proper are made of dry leaves cut into small pieces, of grass, of milkweed floss, and of other plant material. Much of the food is nuts and acorns. Storehouses for these foods are apart from the nest.

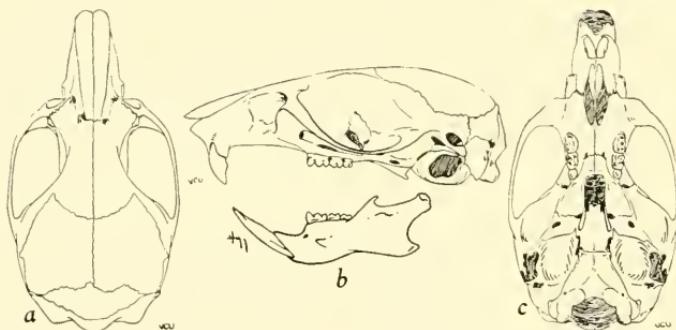
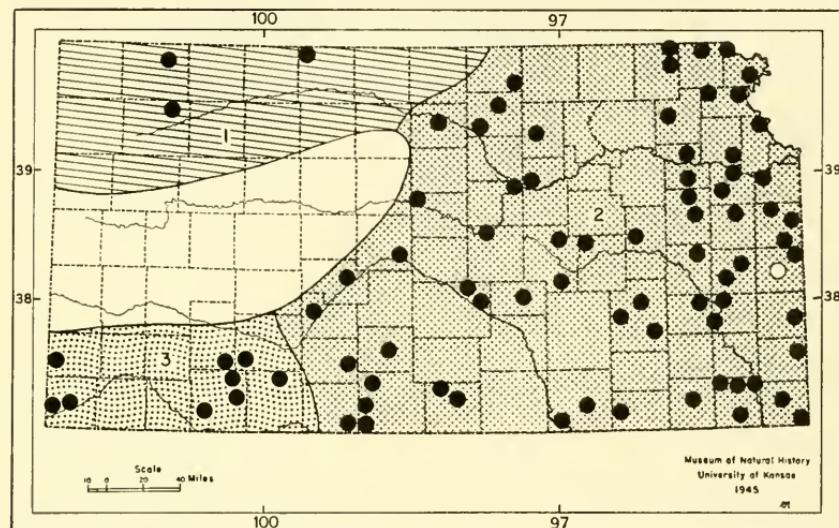


FIG. 36. Skull and left lower jaw of Woods Mouse, *Peromyscus leucopus noveboracensis* (Fischer), 4 mi. S Columbus, Cherokee Co., Kansas, ♂, No. 12360 KU, $\times 1\frac{1}{2}$.

The mice are active throughout the year. In winter, different sexes and ages live together. In summer the Woods Mice are mostly solitary. At weaning time the female deserts her young, leaving them in the old nest. The gestation period seems to be of the same length as in the Deer Mouse. The number of young in a litter varies from one to six. Eyes open on the 10th to 15th day.

In the western part of Kansas the Woods Mouse actually has a fingerlike distribution that is not shown on the accompanying map. This is because the species lives in brushy areas; on the Great Plains these areas are almost entirely along stream courses. The mice are much paler in western Kansas than in eastern Kansas.



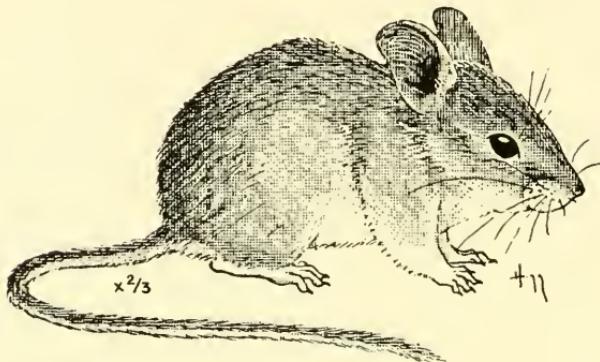
Distribution of *Peromyscus leucopus*. 1. *P. l. aridulus*.
2. *P. l. noveboracensis*. 3. *P. l. tornillo*.

Description.—Total length, 155-196; tail, 66-89; hind foot, 20-23; ear from notch, 16-18; weight (subspecies *noveboracensis*), 28.0-30.7 grams; basilar length of skull, 18.9-22.0; zygomatic breadth, 13.1-14.4. Upper parts, depending on the subspecies, cinnamon rufous with prominent dorsal band of darker color, to fawn uniformly mixed with fine dusky lines; underparts white; tail indistinctly bicolor having a brownish or grayish line on upper side. The Woods Mouse is larger than the Deer Mouse and smaller than the Brush Mouse.

Three subspecies occur in Kansas. *Peromyscus leucopus aridulus* was named by Osgood (N. Amer. Fauna, 28:122, April 17, 1909) with type locality at Fort Custer, Big Horn County, Montana. *P. l. noveboracensis* was named by Fischer (Synopsis Mammalium, p. 318, 1829) from the state of New York. *P. l. tornillo* was named by Mearns (Preliminary diagnoses of new mammals . . . , p. 3, March 25, 1896) with type locality along the Rio Grande, approximately 6 miles above El Paso, El Paso County, Texas. The geographic range in Kansas of each of these subspecies is shown on the accompanying map.

Populations from south-central Kansas that Cockrum (Univ. Kansas Publ., Mus. Nat. Hist., 7:179-180, August 25, 1952) identified as *Peromyscus leucopus texanus* (Woodhouse) are here referred to *Peromyscus leucopus noveboracensis* on the basis of the findings of R. J. Russell (Texas Jour. Sci., No. 4 for December 1953, page 459) and his subsequent verbal advice.

Brush Mouse

Peromyscus boylii (Baird)

This species prefers brushy areas. Furthermore, in Kansas the Brush Mouse has been found only on or near cliffs and ledges of rocks. One writer states that a pile of sticks is erected to harbor the nest. My own experience with this species has been in California, Nevada and Mexico and I have never observed piles of sticks used by the mouse. Additional study is needed to ascertain if Brush Mice

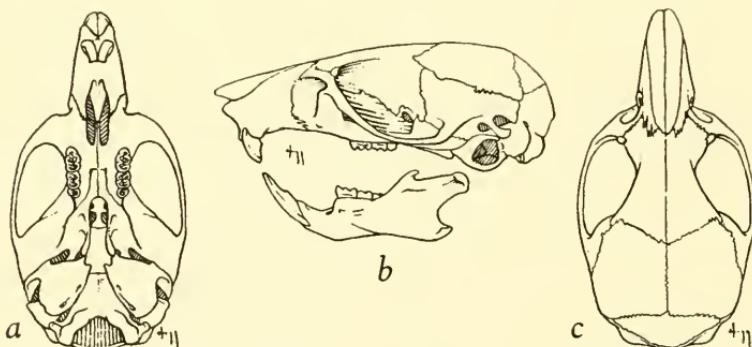
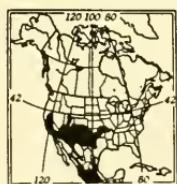
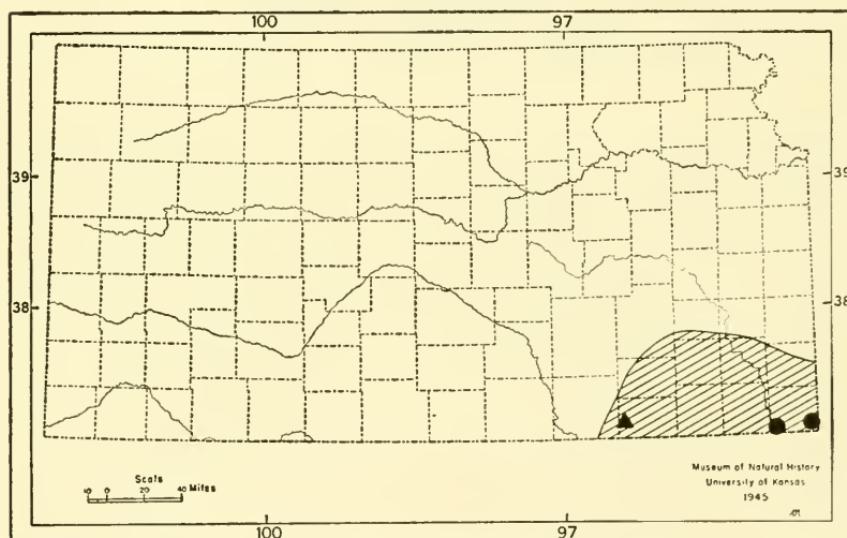


FIG. 37. Skull and left lower jaw of Brush Mouse, *Peromyscus boylii attwateri* J. A. Allen, Ozark, Franklin Co., Arkansas, ♂, No. 10114 KU, $\times 1\frac{1}{2}$.

are dependent on brush or if there is some third factor that accounts for the presence of brush and the mice together. To judge from the habits of some captives that I watched briefly, this species is more scansorial (given to climbing) than is the Deer Mouse or Woods Mouse. The relatively long tail may be an adaptation that better fits the Brush Mouse for climbing.

Two to six young in a litter have been reported. Probably there are several litters per year but accurate information on this point is lacking. If one pair of adults has four litters of five each in a year and if some of the early litters breed and produce young of their own in that year it is easy to see that 100 mice are produced. Observation shows, however, that in the spring of any given year there are approximately only as many mice as there were in the preceding spring. Some die of disease, of course, but the great majority are eaten by other kinds of mammals. The same is true of most small rodents.

The Brush Mouse in Kansas has been found only in the southeastern part of the State. Cedar Vale, in Chautauqua County, is the westernmost occurrence so far recorded.



Description.—Total length, 174-198; tail, 83-104; hind foot, 23-25; ear from notch, 17.5-20.0; basilar length of skull, 19.9-21.5; zygomatic breadth, 13.6-14.2. Upper parts pale buffy cinnamon heavily and uniformly mixed with dusky without any decided concentration in middle of back, general effect being hair brown or sepia; underparts creamy white; lateral line nearly clear ochraceous buff; tail bicolored, brownish above and white below.

This is the largest of the three species of white-footed mice in our State. The tail is approximately the same length as the head and body. In Kansas the skull differs from that of *P. maniculatus* in larger size and from that of *P. leucopus* especially in wider interorbital region and longer tooth-row.

Peromyscus boylii attwateri is the only subspecies reported in Kansas, and was named by J. A. Allen (Bull. Amer. Mus. Nat. Hist., 7:330, November 8, 1895) with the type from Turtle Creek, Kerr County, Texas.

Genus *Sigmodon* Say and Ord
Hispid Cotton Rat
Sigmodon hispidus Say and Ord



Whereas other rodents of Kansas have a markedly different pelage when they are less than a fourth grown than they do when full grown—fine and crinkled in the juvenile as opposed to coarse and straight in the adult—the cotton rat acquires the adult type of pelage when scarcely a fifth grown. These small cotton rats in adult pelage can be mistaken for the Prairie Vole or Cooper Lemming Mouse unless close attention is given to the hind foot, which is longer in the cotton rat, and to the chewing surface of the cheek-teeth, which is made up of rounded cusps in the cotton rat instead of being composed of flat areas of dentine surrounded by enamel. Speaking now of full grown individuals, the Hispid Cotton Rat is approximately 10 inches long including the 4-inch tail; the wood rats are 14 to 15 inches in total length with tails 6 to 6½ inches long; the Norway Rat reaches a total length of 16 inches and the tail makes up only slightly less than half of this length; the Black Rat is of approximately the same length as the Norway Rat but its tail makes up slightly more than half of this length.

The food is predominantly, or entirely, plant material. Runways that are ill-defined in comparison with the sharply defined runways of *Microtus* are made in grass and especially in weedy areas. Nests of grass and shredded plant fibers are built on top of the ground under almost any sort of convenient cover. The gestation period is 27 days and the number of embryos recorded ranges from 3 to 12. Litters of 2 to 10 young are recorded, the average number of young being 5.6 according to our data.

The Hispid Cotton Rat reproduces well in captivity and has served usefully in recent years in the study of the virus organisms that cause influenza in man. Also this mammal has been used in studying the effects of "atomic" materials on mammalian life. It is dangerous to exterminate any species of animal or plant; in the future, man, himself, probably will have a use for it! The usual meaning of the word "conservation" is to preserve for use; the term "soil conservation" has precisely that connotation. For a kind of mammal that is neither directly useful to man nor harmful to him,

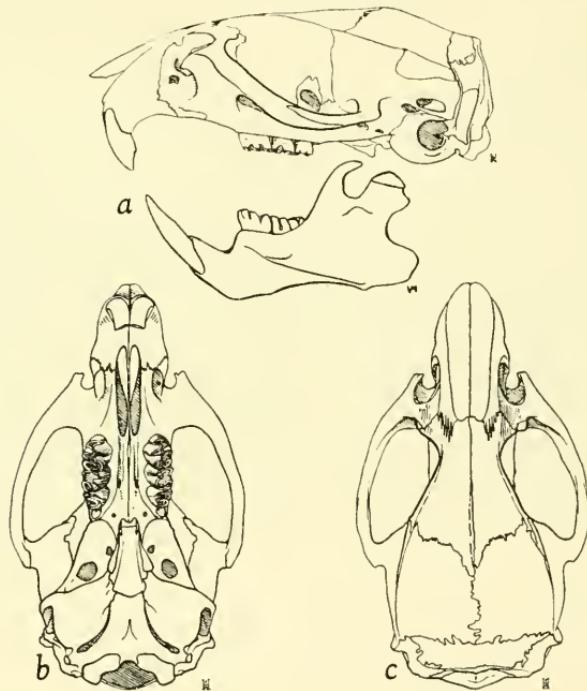
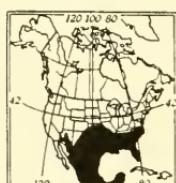
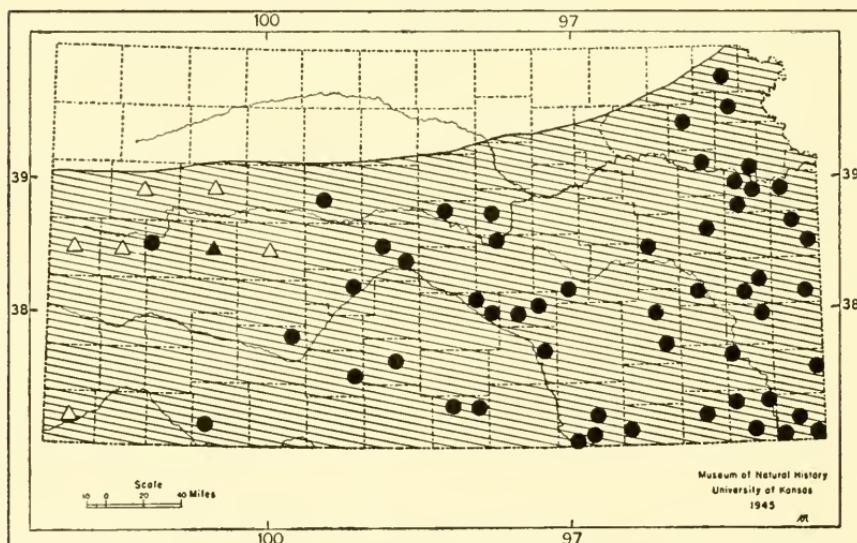


FIG. 38. Skull and left lower jaw of Hispid Cotton Rat, *Sigmodon hispidus* [subspecies *plenus* Goldman], Colorado River, $\frac{1}{2}$ mi. N California-Nevada Monument, Clark Co., Nevada, ♀, No. 61836 MVZ, $\times 1\frac{1}{2}$.

however, the average man's reaction is "since it's no good, kill it." But for a mammal that damages cultivated crops at certain places and times, as the cotton rat may, it is even more difficult to gain the average man's support in conserving it. Since he knows that it needs to be eradicated locally under certain situations he ordinarily wrongly concludes that it needs to be eradicated everywhere, or that if fewer are better none is best!

To the northward the Hispid Cotton Rat has been reported from Logan and Gove counties. One specimen is available from immediately south of Hays in Ellis County and another from a place 5 miles south of Hiawatha in Brown County. From a line connecting these four places the cotton rat occurs over all of the state to the southward. In the period 1933 to 1947 the cotton rat expanded its geographic range northward for a hundred miles—from Greenwood and Allen counties into Brown County. If this rat is found at still more northern localities in Kansas the author will appreciate being informed. Some persons have suggested that this northward movement is a response to a climate now warmer than existed a century ago in northern parts of the state of Kansas.



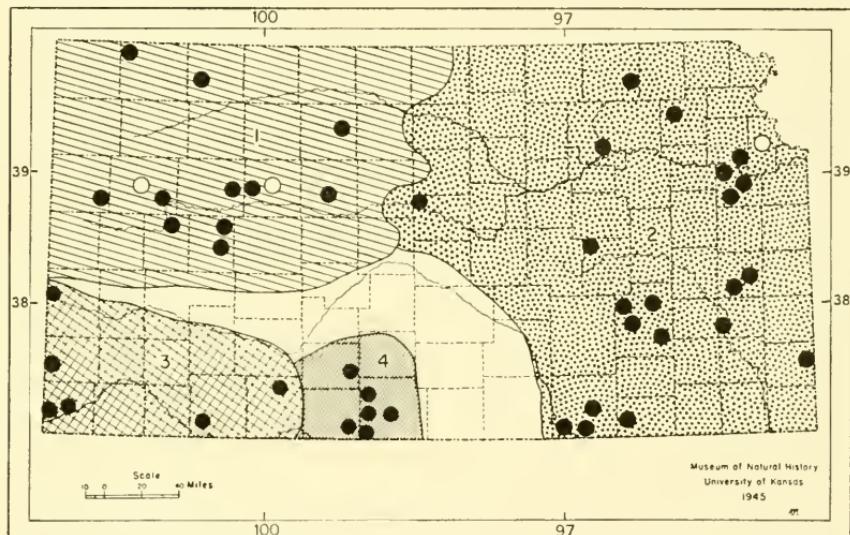
Description.—Maximum measurements in our specimens are: Total length, 277; tail, 111; hind foot, 35; ear from notch, 20; weight, 103.4 grams (approximately 4 ounces); greatest length of skull, 38.6; zygomatic breadth, 210. Upper parts grayish brown to buffy gray with admixture of black resulting in grizzled appearance; underparts whitish, usually light gray; tail blackish above and whitish below but not sharply bicolored and so thinly haired as clearly to reveal annulations. The shorter tail of the cotton rat in comparison with that of the wood rats, Norway Rat and Black Rat is a useful recognition character. The different arrangement of cusps on the chewing surfaces of the cheek-teeth provides other recognition characters.

The one subspecies in Kansas is *Sigmodon hispidus texianus* named by Audubon and Bachman in the Quadrupeds of North America (3:229, 1853). The specimen on which the description was based is stated to have been taken along the Brazos River in Texas.

Wood Rats

Genus *Neotoma* Say and Ord

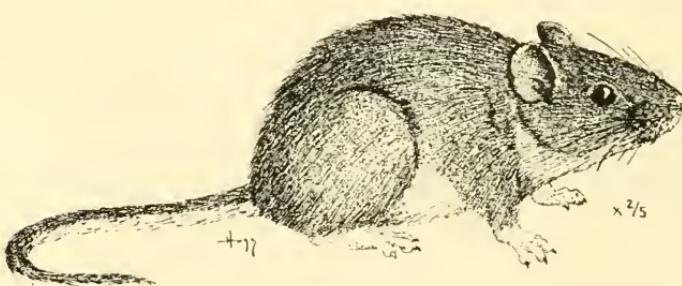
Two species of this native genus occur in Kansas. They can readily be distinguished from the two species of the non-native genus *Rattus* (introduced from the Old World) by the cheek-teeth. In *Rattus* the grinding surfaces are studded with definite cusps whereas in *Neotoma* the grinding surfaces are flat and are made up of lakes of dentine surrounded by enamel. The lakes are more or less separated from one another by re-entrant angles. Also, the tail is more hairy in *Neotoma*.



Distribution of *Neotoma floridana* and *Neotoma micropus*. 1. *N. f. campestris*.
2. *N. f. osagensis*. 3. *N. m. canescens*. 4. *N. m. micropus*.

Eastern Wood Rat

Neotoma floridana (Ord)





In western Kansas this species of wood rat packs sticks and twigs into cracks and crevices of rock ledges and makes its nest there. In eastern Kansas too it favors the crevices and slitlike caves in outcropping ledges of limestone where brush and trees occur. After these places are preempted the other rats build their houses in brush piles, under fallen trees, around the bases of trees, or, less frequently, in the branches of trees. At the times when these rats were abundant in Douglas County, as they were in 1945 and 1946, houses were to be found along fence rows of Osage orange trees. Almost every house is in a place where it is shaded in summer for most, or all, of the day.

A typical house is cone-shaped, four feet in diameter at the base and three feet high. It is constructed principally of twigs and sticks as large as the rats can carry. New material is added at the top and in season the twigs and branches have attached leaves which tend to fill the spaces between the sticks. Almost anything else that is available in the vicinity and that is convenient for a rat to carry goes to make up the house. Old bones, pieces of cow chips, chips from a woodsman's axe, and occasionally small stones all go into the structure of the house.

Inside the house there are sizable galleries. The nest is built in a gallery and is made of dried grass and plant fibers. It is a cup-shaped structure open at the top. There are two or more nests in a like number of galleries in a typical house. From the lowermost gallery a blind burrow or system of burrows in the earth provides an underground retreat into which the rat can go when its house is torn apart. Openings through the side of the house at and above ground-level give access to well-beaten paths and if the rat finally flees from its house it invariably follows one of these.

In autumn a person who dissects a wood-rat house commonly finds in one of the galleries a sizable store of freshly cut berries or foliage to be used as food and so arranged that it can be reached by the rat from its reclining position in the nest. Other galleries in the house at this season may be crammed full of dried or less perishable foods. In general there is a segregation of food. One house that I recall six miles northeast of Lawrence yielded more than two gallons of hazel nuts, one and a half gallons of wild grapes, a quart of partly dried mushrooms, between three and four dozen hickory nuts, and a score or more sprays of bittersweet berries.

In the autumn of 1952 it was discovered that all but three apples from a full bushel measure that was sitting on the ground floor of my garage—formerly a barn—had disappeared. Next day those three apples were gone. Fox Squirrels wrongly were accused at first but closer inspection and search revealed the whole lot of apples in a corner of the second floor in some unused stove pipes. In that place there was also a neatly constructed nest of wood-rat size made of a reserve supply of steel wool! A live-trap set there caught a half grown Eastern Wood Rat and next day an adult was seen.

From one to four young have been found with a female and our observations indicate the male lives in a house apart from that in which the female cares for her young.

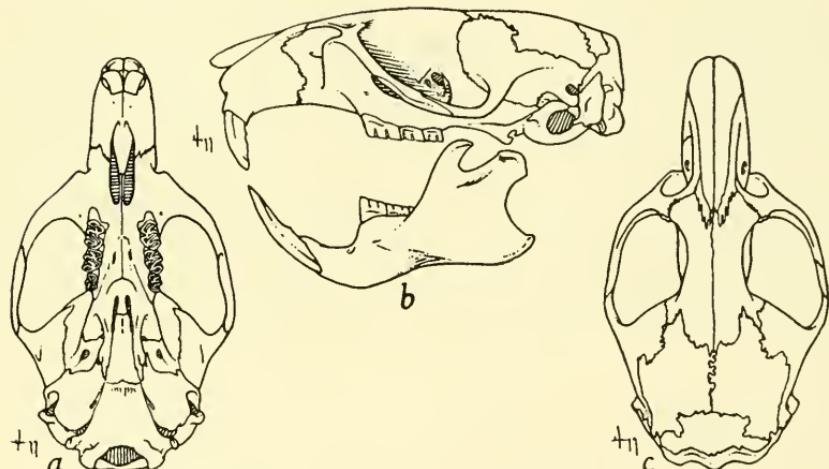


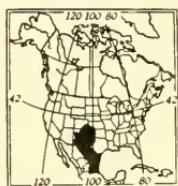
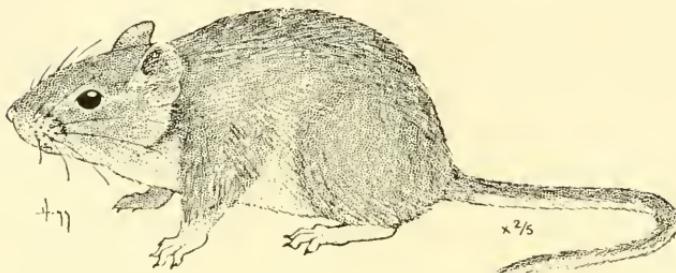
FIG. 39. Skull and left lower jaw of Eastern Wood Rat, *Neotoma floridana osagensis* Blair, 6 mi. N and 12 mi. E Arkansas City, Cowley Co., Kansas, ♂, No. 39283 KU, natural size.

The Eastern Wood Rat occurs in all parts of Kansas north and east of the Arkansas River.

Description.—Total length, 310-395; 129-175; 35-42; 25-26; condylobasal length of skull, 37.5-50.0; zygomatic breadth, 24.5-28.4. Upper parts buffy-gray to brownish gray in eastern Kansas to buffy-ochraceous in western Kansas; underparts with plumbeous fur tipped with white; tail bicolored although indistinctly so in individuals from western Kansas.

Two subspecies are recognized in Kansas. *Neotoma floridana campestris* in the western part of the State was named by J. A. Allen (Bull. Amer. Mus. Nat. Hist., 6:322, November 7, 1894) with type locality at Pendennis, Lane County, Kansas. *Neotoma floridana osagensis* in the eastern half of the State was named by Blair (Occas. Papers Mus. Zool., Univ. Michigan, 403:5, June 16, 1939) with type locality at Okesa, Osage County, Oklahoma.

Gray Wood Rat
Neotoma micropus Baird



In Kansas the Gray Wood Rat occurs in most parts of the State south and west of the Arkansas River. Its houses resemble those of the Eastern Wood Rat and were abundant in 1950 in ledges of rock in Stanton County. The gestation period is 33 days and there are one to three young per litter.

Description.—Total length, 307-390; tail, 120-168; hind foot, 36-41; ear from notch, 23-32; condylobasal length of skull, 46.7-50.0; zygomatic breadth, 25.7-28.8. Upper parts gray, underparts pure white. From *Neotoma floridana*, *N. micropus* differs in gray (not fulvous or rufous) upper parts; pure white instead of basally plumbeous fur on underparts; and longer incisive foramina (more, instead of less, than 11 mm.).

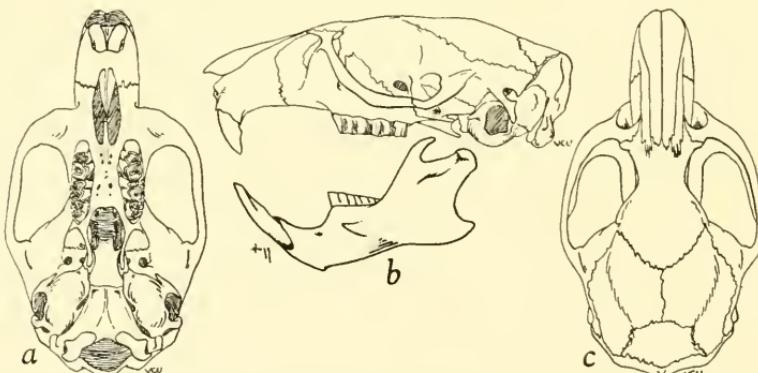


FIG. 40. Three views of skull and left lower jaw of Gray Wood Rat, *Neotoma micropus micropus* Baird, State Park, Meade Co., Kansas, ♂, No. 12753 KU, Natural size.

Two subspecies occur in Kansas. *Neotoma micropus canescens* was named by J. A. Allen (Bull. Amer. Mus. Nat. Hist., 3:285, June 30, 1891) with type from along the Canadian River, near the Oklahoma-New Mexico line in Cimarron County, Oklahoma. *Neotoma micropus micropus* was named by Baird (Proc. Acad. Nat. Sci. Philadelphia, 1885:333, April) with type locality at Charco Escondido, in the state of Tamaulipas of the Republic of Mexico.

Genus *Synaptomys* Baird
 Southern Lemming-mouse
Synaptomys cooperi Baird



In the sixty-year period, 1892-1952, that trapping of small mammals has been carried on at Lawrence in Douglas County of eastern Kansas this mouse seems to have been abundant only in the five year period, 1924-1928. At Lawrence the runways were above ground in fields of bluegrass. The runways criss-crossed one another and so closely resembled those of the Prairie Vole that positive identification of the inhabitant could not be made by inspection of the runways alone. A fairly positive identification could be made, however, by examining the droppings (faeces) in the runways. The fresh faeces are light green if from *Synaptomys* but are brown or blackish if from *Microtus*.

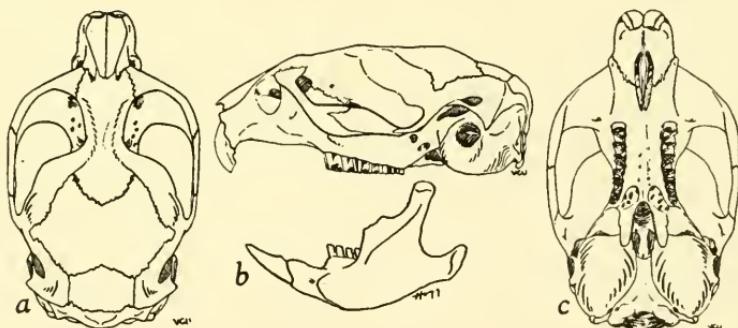
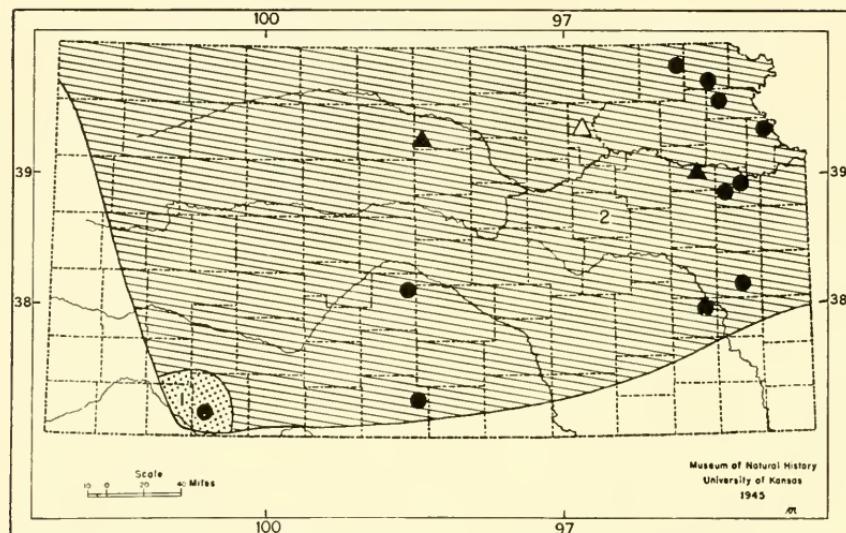


FIG. 41. Skull and left lower jaw of Southern Lemming-mouse, *Synaptomys cooperi gossii* (Couch), 1 mi. W Lawrence, Douglas Co., Kansas, ♂, No. 4626 KU, $\times 1\frac{1}{2}$.

The mice are active throughout the year. The food is green vegetation. The nests in winter are four to six inches below ground but in summer many are on the surface of the ground. The nest is made of dry grass, sometimes is lined with fur, is six to

eight inches in diameter and has two to four openings. Embryos number one to seven. Young are born in all months of the year but most of them are born in the warmer months.



Distribution of *Synaptomys cooperi*.
1. *S. c. paludis*. 2. *S. c. gossii*.

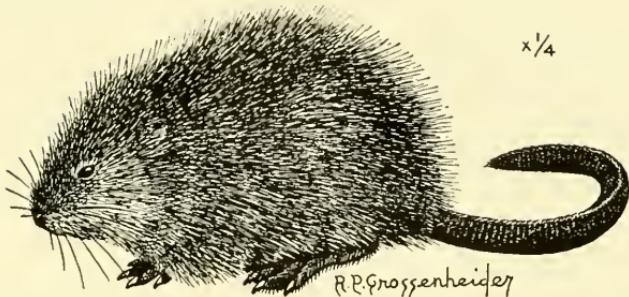
The geographic distribution is state-wide or almost so. Specimens have been found in, and at the edges of, marshes and bogs, on dry upland in dense stands of bluegrass (at Lawrence) and on dry upland in ungrazed bluestem (1 mi. E and 3 mi. N of Sharon in Barber County). The southwesternmost record station of occurrence is a marsh 14 miles southwest of Meade, Meade County.

Description.—Total length, 122-154; tail, 18-33; hind foot, 17-22; ear from notch, 10-14; weight 39-49 grams; condylobasal length of skull, 24.5-30.6; zygomatic breadth, 15.8-19.7. Upper parts cinnamon brown; underparts plumbaceous or creamy; mandibular molars with triangles on outer sides; occlusal faces of cheek-teeth made up of tracts of dentine surrounded by enamel; tracts more or less separated from one another by re-entrant angles; upper incisors grooved (groove close to outside border). The Southern Lemming-mouse can be distinguished from all other mice in the State by the short tail which is little if any longer than the hind foot, by the groove near the outer margin of the upper incisor (groove nearer middle of tooth in *Reithrodontomys* and *Perognathus*) and by the enamel pattern of the cheek-teeth.

Two subspecies occur in Kansas. *Synaptomys cooperi gossii* was named by Coues (Monograph of North American Rodentia, p. 235, 1877) with type locality at Neosho Falls, Woodson County, Kansas. *Synaptomys cooperi paludis* was named by Hibbard and Rinker (Kansas Univ. Sci. Bull., 28 (pt. 1, no. 2):26, May 15, 1942) with type locality in Meade County State Park, fourteen miles southwest of Meade, Meade County, Kansas.

Genus *Ondatra* Link

Muskrat

Ondatra zibethicus (Linnaeus)

The Muskrat lives where there is water deep enough to dive into and escape enemies. Most of our Muskrats live in burrows. A typical burrow has the entrance below water and leads upward to a grass nest in an enlargement of the burrow which may continue on to a second opening on the surface of the ground atop the bank. In swamps and marshes where the water is no more than two feet deep the Muskrat builds a cone-shaped house approximately five feet in diameter at the base and four feet high. Such a house is built of cattails and other vegetation and above water level has a dry chamber which serves as a sleeping place. Tunnels lead to openings below water.

In 1952 and in each of several preceding years the Muskrat surpassed any other North American fur-bearing mammal in the total value of fur that was marketed. In the United States alone the annual return is roughly thirty million dollars per year to trappers for the raw fur. The fur wears well and is glossy and pleasing to the eye. Hudson Seal is one name under which the fur often is sold to the wearer. In Kansas—and in several other states—the open season for trapping fur-bearing mammals is December and January although the pelts of most Muskrats seldom are prime before February or March. Several other kinds of fur-bearers are best taken earlier than February and it is difficult to prevent their capture if traps are set in February and March for Muskrats. Because of the value of its fur, the Muskrat was introduced into Europe and Asia. The animal became such a pest in parts of Europe that vast sums have been spent there in efforts to eradicate it. Large dark pelts are most valuable and small pale pelts are least valuable.

The darkest and largest muskrats are native to Alaska and to the northeastern United States. Many Muskrats have been captured alive there and transported to, and released in, other areas. In some large cities in the eastern United States the skinned carcasses of Muskrats are sold in meat markets under the name "Marsh Rabbit."

The rootstalks of cattails and tules are favorite foods. In marshes a mat of tules or cattails serves as a feeding platform. A sunken log, part of which protrudes above water, or a flat place at the water's edge sheltered by a steep bank are common feeding sites. Some animal matter is eaten; mussels are frequently consumed.

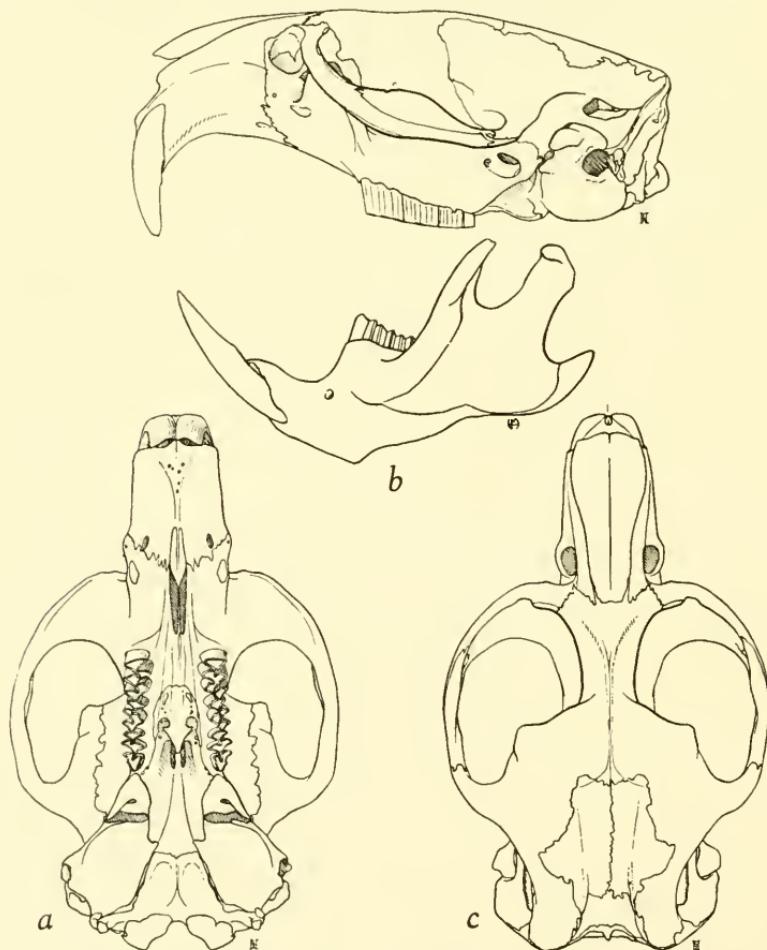
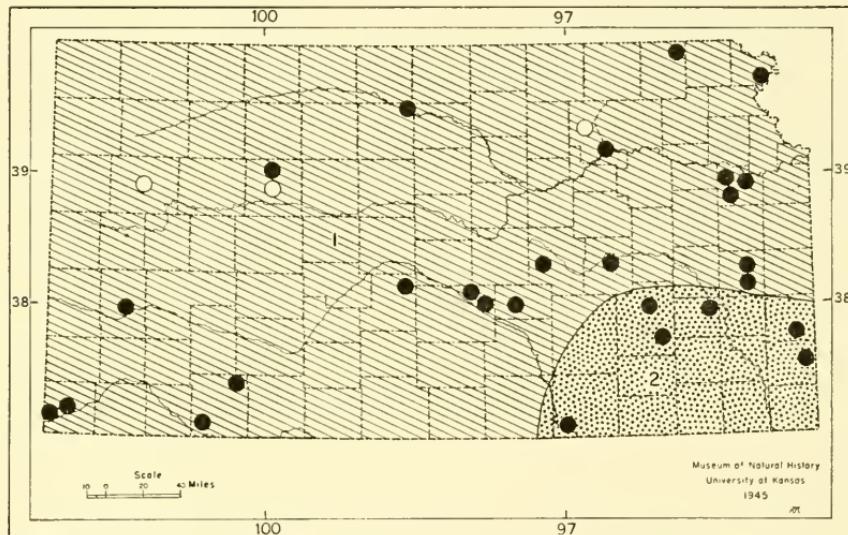


FIG. 42. Skull and left lower jaw of Muskrat, *Ondatra zibethicus* [subspecies *mergens* (Hollister)] 10 mi. SE Fallon, Churchill Co., Nevada, ♂, No. 90544 MVZ, natural size.

Muskrats are mainly nocturnal but if watched for they frequently can be seen swimming in the daytime. Some are found far from any water. These are individuals migrating to a body of water which will serve as a new home.

Some females have as many as three litters per year. Six is a common number of young in a litter. At birth the young Muskrat of average size weighs only two per cent (21.3 grams) as much as the adult female. The eyes open between the twelfth and twentieth days of life, commonly on the 14th, 15th, or 16th day. Most young are weaned in the fourth week of life. When 70 to 90 days old the animal, by weight, is half grown.



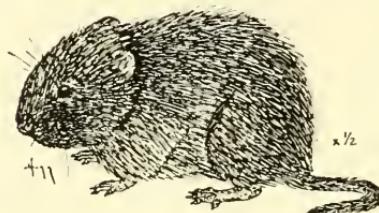
Distribution of *Ondatra zibethicus*.
1. *O. z. cinnamominus*. 2. *O. z. zibethicus*.

Description.—Total length, 456-553; tail, 200-254; hind foot, 65-78; ear from notch, 20-21; condylobasal length, 57.6-64.1; zygomatic breadth, 35.6-39.8. Color dark brown, darkest on back where overhair is thickest; sides more reddish; underparts with silvery-tipped hairs; tail nearly as long as body (not including head), laterally compressed, with distinct dorsal and ventral keels, and so scantily haired as to reveal scales which are about 2 millimeters in diameter; hind feet large and partly webbed, with fringe of stiff hairs on edge of webs, on sides of toes, and on forepart of feet; mammae 8 to 10 or even 11, two pairs inguinal, others pectoral; ears barely projecting above fur.

In Kansas there are two subspecies. *Ondatra zibethicus cinnamominus* was named by Hollister (Proc. Biol. Soc. Washington, 23:125, September 2, 1910) with type locality at Wakeeney, Trego County, Kansas. *Ondatra zibethicus zibethicus* ranges into the southeastern part of the State and was named by Linnaeus (Systema Naturae, ed. 12, 1:79, 1766) with type from eastern Canada.

Genus *Microtus* True
Prairie Vole

Microtus ochrogaster (Wagner)



Prairie Voles require a cover of grass or clover dense enough to conceal them from their enemies when the voles are in their runways. When the cover is removed the voles move to areas having cover or abandon their surface runways and remain below ground except when there is a protective blanket of snow. Runways through the grass are 40-50 mm. wide and usually lie slightly below the surface of the ground because repeated use by the voles converts the runways into miniature ruts. The bottom of a runway is bare soil or is covered with only a thin layer of trampled grass. The Prairie Vole makes a tortuous network of surface runways through the grass and honeycombs the topsoil with its tunnels. These tunnels, or burrows, are 40 to 50 mm. in diameter and the shallowest of the burrows are 50 mm. below the surface of the ground. These burrows are made when the soil is moist and easily excavated and few burrows are dug when the soil is dry and hard.

Caches of seeds and the underground parts of plants are stored in subterranean chambers in the burrow system. One cache found on May 27 on the campus of the University of Kansas at Lawrence by E. W. Jameson, Jr., consisted of eight quarts of seeds of the Kentucky coffee tree. A seed of this tree weighs two grams and there were approximately 2800 seeds, packed in loose earth and well preserved. The oval chamber was 250 mm. wide, 400 mm. long and 200 mm. high. The highest point of the ceiling was 30 mm. below the surface of the ground. There were two entrances to the cavity, both on the downhill side.

Most of the food of the Prairie Vole is green vegetation. At Lawrence, E. W. Jameson listed 10 grasses, four legumes, five composites, and a species each of the genera *Solanum*, *Galium*, and *Lonicera* as eaten by these mice.

The nests are made of dry plant material, in cavities below ground that are up to eight inches across, horizontally, and half as high. These cavities are six to 18 inches below the surface of the ground and are connected with the burrow system by a pair of tunnels. The young are born in underground nests from February through November at Lawrence. The size of the litter varied with the age of the female and with the season. The size of the litters was largest for old females and for the month of March. In 58 gravid females the number of embryos varied from 1 to 7 and averaged 3.4.

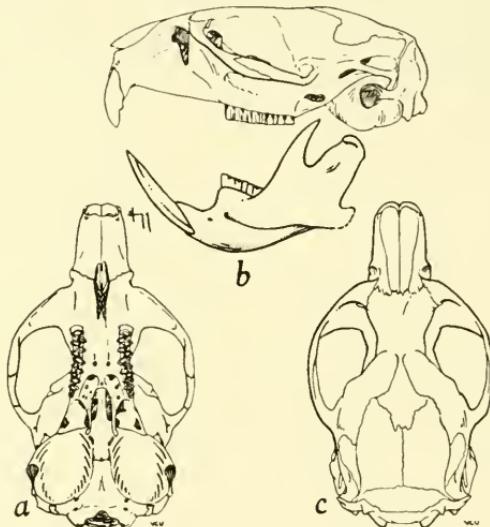
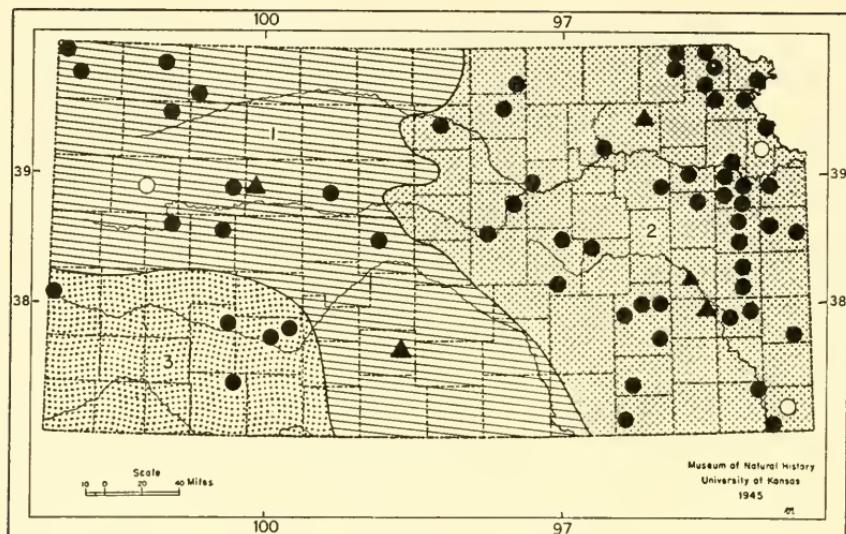


FIG. 43. Skull and left lower jaw of Prairie Vole, *Microtus ochrogaster ochrogaster* (Wagner), Lawrence, Douglas Co., Kansas, ♀, No. 1075 KU, $\times 1\frac{1}{2}$.

From 1950 to 1952 inclusive, Edwin P. Martin studied this species on the University of Kansas Natural History Reservation six and a half miles northeast of the University proper. In 1950 there was normal precipitation (36 inches) and many voles; in 1951 there were 51 inches of precipitation and fewer voles because the heavy rainfall killed many juveniles; in 1952 there were only 24 inches of precipitation and still fewer voles because drought conditions altered the plants in such a fashion as to make less favorable food with the result that the voles almost ceased reproducing. Even so there were more voles in 1952 than in 1948 (32 inches of precipitation) because livestock ate most of the plant-cover in 1948.



Distribution of *Microtus ochrogaster*.

1. *M. o. haydenii*. 2. *M. o. ochrogaster*. 3. *M. o. taylori*.

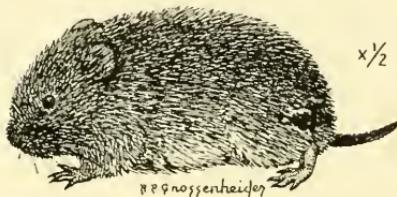
Record stations of occurrence, shown on the map, that are additional to those previously shown by Cockrum (Univ. Kansas Publ., Mus. Nat. Hist., 7:202, fig. 55, August 25, 1952) are, by subspecies, as follows: *M. o. haydenii*—15 mi. N and 11½ mi. W St. Francis (Cheyenne Co.); 1 mi. W St. Francis (Cheyenne Co.). *M. o. ochrogaster*—9/10 mi. W Dover in Wabaunsee Co.; 8½ mi. W and 3 3/10 mi. S Topeka, Shawnee Co.; 1¾ mi. W and 1½ mi. S Moline, Elk Co. *M. o. taylori*—3 mi. N and ¾ mi. W Cimarron, Gray Co.

Description.—Total length, 121-170; tail, 25-42; hind foot, 17-22; weight in grams, 38-58; condylobasal length of skull, 24.2-30.7; zygomatic breadth, 14.2-17.6. Upper parts light gray (in western Kansas) to dark bister (in eastern Kansas), with peppery appearance resulting from mixture of black and whitish, pale fulvous or hazel-tipped hairs; sides paler; underparts neutral gray or washed with whitish or pale cinnamon; tail sharply bicolor, dusky to dark bister above, whitish to buffy below; mammae 6. From the Cooper Lemming Mouse this species differs in longer tail, and in posterior end of lower incisor which passes lateral (instead of medial) to root of last lower molar and in that incisor terminates in condylar process of mandible instead of in horizontal ramus opposite or in front of last lower molar. From the Pine Mouse, the Prairie Vole differs in longer tail, 6 instead of 4 mammae, long lax brown fur instead of short glossy reddish fur.

The three subspecies in Kansas are as follows: *Microtus ochogaster haydenii*, in the northwestern part of the State, named by Baird (Mammals of North America, p. 543, July 14, 1858) with type locality at Fort Pierre, Stanley County, South Dakota; *M. o. ochrogaster*, in eastern Kansas, named by Wagner (Schreber's Säugetiere . . . Supplement, 3:592, 1842) with type probably from New Harmony, Indiana; and *M. o. taylori*, in southwestern Kansas, named by Hibbard and Rinker (Kansas Univ. Sci. Bull., 29 (pt. 2, no. 4):256, October 15, 1943) with type locality one and one-half miles north of the town of Fowler in Meade County, Kansas.

Pine Vole

Microtus pinetorum (Le Conte)



The Pine Vole usually is associated with woods. The runways are of approximately the same size as those of the Prairie Vole, in fallen leaves and other ground cover. In some places the Pine Vole makes runways in grass but these runways are mostly under trees. The late Dr. Glenn C. Rinker took many specimens on a railroad embankment in a brushy, as opposed to a timbered, area. Whereas the Prairie Vole makes runways on the surface of the ground, and the Eastern Mole makes runways underground, the Pine Vole splits the difference and its runway is half in the ground and half in the leaf-litter above. This habit of digging more than does the Prairie Vole is reflected in the pelage of the Pine Vole; the hair is finer, glossier and seems to be shorter than in the Prairie Vole but not so short and velvetlike as in the mole.

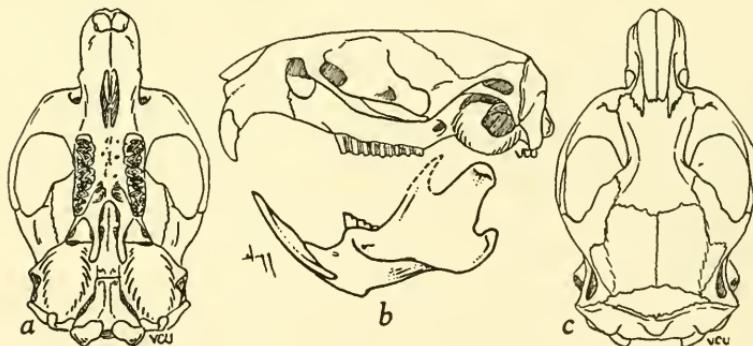
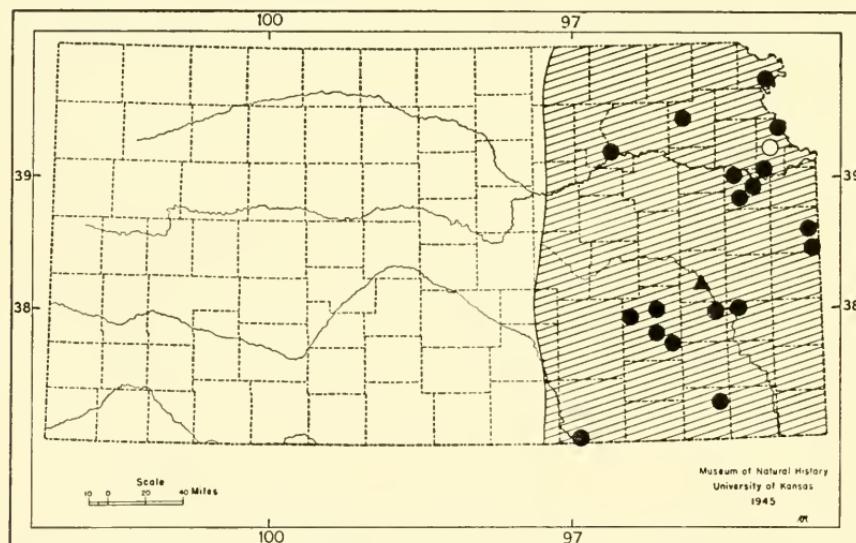


FIG. 44. Skull and left lower jaw of Pine Vole, *Microtus pinetorum nemoralis* Bailey, 8½ mi. SW Toronto, Greenwood Co., Kansas, ♀, No. 8038, KU, $\times 1\frac{1}{2}$.

Pine Vole is to some extent a misleading name because this species lives in deciduous woods rather than in pine woods or than in coniferous woods of any sort. Extensive digging is done by means of the forefeet and upper incisor teeth.

Nests are globular, of dead leaves and grass, usually are just below the surface of the ground, and less often are under some shallow-rooted stump. Some nests contain green vegetation. The animal feeds mostly on succulent roots and tubers.

There are two to five young per litter—fewer than in the Prairie Vole. But the breeding season is longer for the Pine Vole. At birth the weight is eight per cent (2.2 grams) of the adult weight. Young commence to eat on the 16th day and are weaned on the 17th day, according to Dr. William J. Hamilton, Jr. The dark juvenal pelage is retained for five weeks; at seven weeks the mice have the paler adult pelage.



The Pine Vole is to be found in suitable habitat in most parts of the eastern third of the State. Manhattan in Riley County and 3 mi. SE Arkansas City in Cowley County are the westernmost record stations of occurrence so far known in the State.

Description.—Total length, 122-141 mm.; tail, 22-26; hind foot, 18-19; ear from notch, 11-12; weight in grams, 27.3-39.6; condylobasal length of skull, 24.2-26.7; zygomatic breadth, 13.9-15.7. Upper parts bright russet brown to brownish chestnut, some individuals lined with blackish-tipped hairs on back and rump; underparts plumbeous with wash of dull buff to bright cinnamon; tail indistinctly bicolor or even unicolor, in most individuals same color as back. There are four mammae and five plantar pads; sole of hind foot not fully haired; skull closely resembling that of *Microtus ochrogaster*.

In Kansas there is only the one subspecies, *Microtus pinetorum nemoralis* Bailey (Proc. Biol. Soc. Washington, 12:89, April 30, 1898), with type locality at the town of Stilwell in Adair County, Oklahoma.

Old World Rats and Mice

FAMILY MURIDAE

The two species of rats and the House Mouse, all natives of Eurasia, have accompanied man in his ships to all continents and now are established in most parts of the United States.

The relatively naked ears and scantily haired tail on which the annulations of scales are prominent are characteristic external features. From native rats and mice these species from the Old World differ in having three, instead of only two, longitudinal rows of tubercles on the molar teeth.

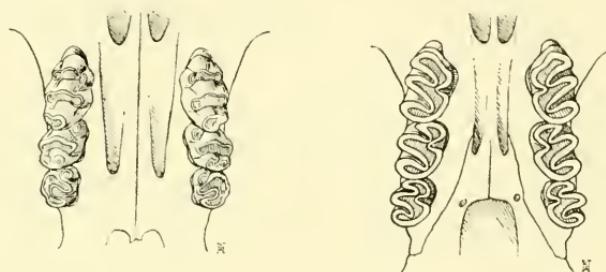


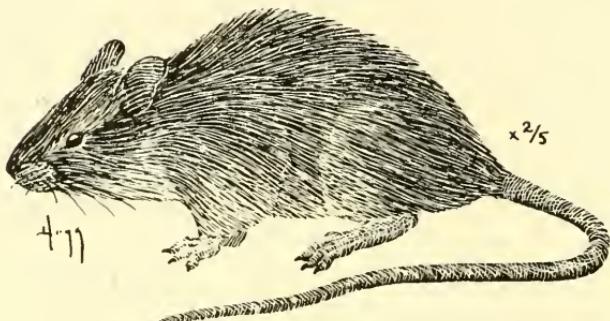
FIG. 45. Enlarged views (3 times natural size) of the chewing surfaces of the upper cheek-teeth of a non-native rat on the left (*Rattus rattus alexandrinus*, Reno, Nevada, ♀, No. 94922 MVZ) and of the wood rat on the right (*Neotoma lepida lepida* Thomas, Baker Creek, 7300 ft., White Pine Co., Nevada, ♀, No. 42031 MVZ). The teeth are worn approximately the same amount in each of the two animals. Note the three rows of longitudinal cusps in *Rattus* and that *Neotoma* has instead a flat chewing surface. This surface is made up of lakes (technically lophs) of dentine surrounded by enamel. The re-entrant angles on the outside of the tooth also are a characteristic feature in *Neotoma*. The differences here shown between *Rattus* and *Neotoma* will serve to distinguish the species, that occur in Kansas, of these two genera.

KEY TO MURIDS—OLD WORLD RATS AND MOUSE

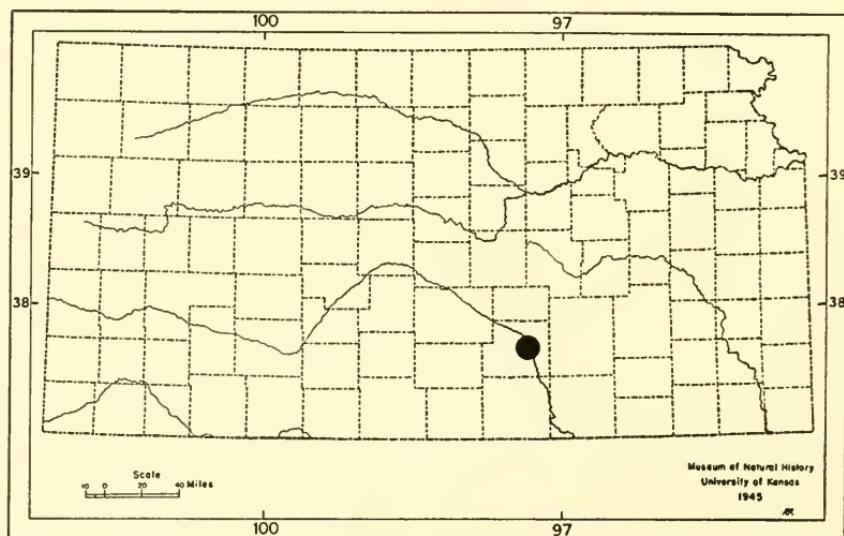
1. Hind foot less than 22; greatest length of skull less than 30; no heavy ridges on skull (see fig. 48) House Mouse, page 158
- 1'. Hind foot more than 22; greatest length of skull more than 30; heavy ridges over orbits and posteriorly on skull (see figs. 46 and 47).
2. Tail shorter than head and body; length of parietal bone measured along a temporal ridge approximately equal to greatest distance between temporal ridges Norway Rat, page 156
- 2'. Tail longer than head and body; length of parietal bone measured along a temporal ridge less than greatest distance between temporal ridges Black Rat, page 154

Genus *Rattus* G. Fischer

Black Rat

Rattus rattus (Linnaeus)

This non-native species is positively known to me from Kansas by specimens caught in 1950 and 1954 in Wichita and preserved in the Museum of Natural History of the University of Kansas at Lawrence. In many temperate parts of North America where the Black Rat once was abundant it has become rare, or has been driven out, by the other non-native species, the Norway Rat. The Black Rat climbs more skillfully than the larger, shorter-tailed Norway Rat.



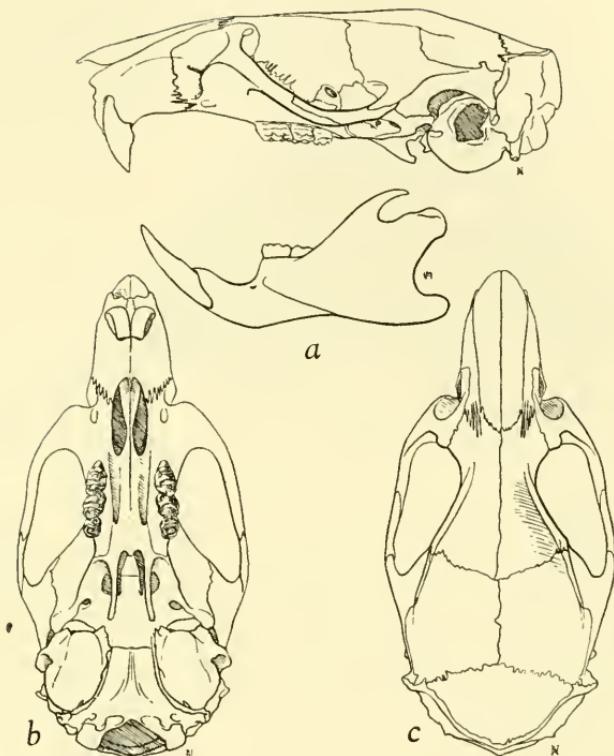
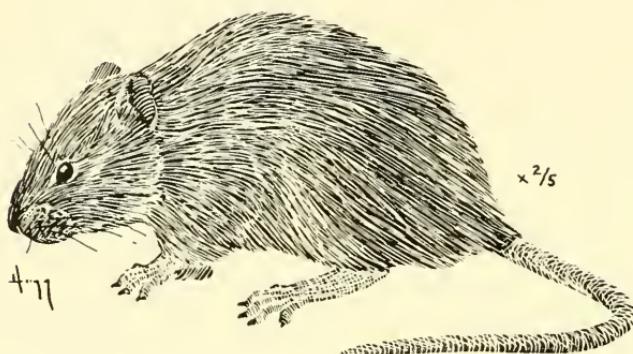


FIG. 46. Skull and left lower jaw of Black Bat, *Rattus rattus alexandrinus* (Geoffroy), Reno, Washoe Co., Nevada, ♀, No. 94922 MVZ, $\times 1\frac{1}{2}$.

Description.—A male from Wichita measures approximately as follows: Total length, 381; tail, 203; hind foot, 38; occipitonasal length of skull, 39.7; zygomatic breadth, 18.9. Upper parts brownish gray; underparts creamy white. Compared with the Norway Rat, the Black Rat has a smaller body, smaller hind foot, larger external ear conch, longer tail (longer, instead of shorter, than the head and body), five (instead of six) pairs of mammae of which two, instead of three, are pectoral and outwardly bowed, instead of parallel, temporal ridges on the skull. Still another distinction in the skulls is that the length of the parietal bone measured along a temporal ridge is less than, instead of approximately equal to, the greatest distance between these ridges.

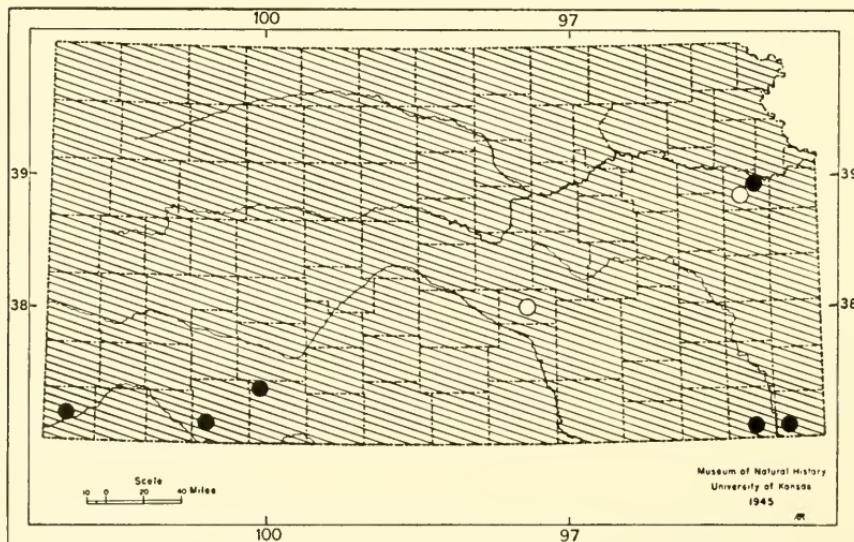
One subspecies, *Rattus rattus alexandrinus* (Geoffroy), is known from Kansas and was originally described (Catal. Mam. du Mus. Nat. d'Hist. Nat. Paris, p. 192, 1803) with type locality at Alexandria, Egypt.

Norway Rat

Rattus norvegicus (Berkenhout)

This non-native species is common throughout the State. With the onset of cold weather in autumn it tends to leave the creek banks and fields and retreats to buildings and other man-made structures. Some live in and around buildings throughout the year—both at farmsteads and in towns and cities. In mild winters in Douglas and Franklin counties I have known these rats to live away from buildings even in winter.

The Norway Rat damages stored grain, most kinds of food stored by man and even kills young poultry. Rat-proofing buildings is the surest means of preventing damage. Of the many means used



to kill rats, trapping has the advantage of allowing the bodies of the rats to be disposed of in such a manner that objectionable odors from decay are prevented. Red squill is the safest of the poisons that have been tried. Persons and most domestic animals vomit and expel the red squill but rats cannot vomit and are killed by it.

Litters of one to 12 have been recorded for this species, but the average is nearer six.

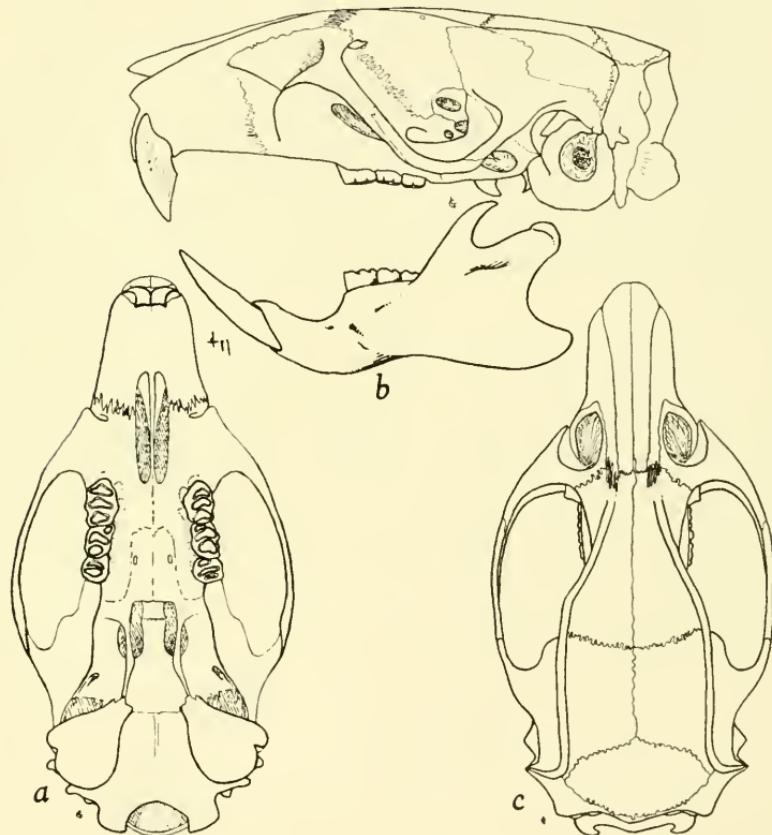


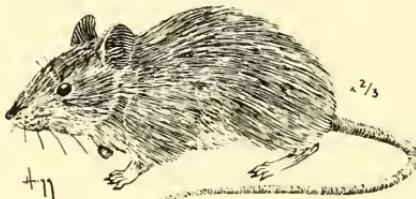
FIG. 47. Skull and left lower jaw of Norway Rat, *Rattus norvegicus norvegicus* (Berkenhout), Redlands, San Bernardino Co., California, ♂, No. 77258 MVZ, $\times 1\frac{1}{2}$.

Description.—Total length, 294-325; tail, 125-190; hind foot, 35-42; occipitonasal length, 38.2-50.5; zygomatic breadth, 15.8-18.1. Upper parts and sides dark brownish; underparts and feet grayish. Comparison with the Black Rat has been made in the account of that species.

Only the one subspecies, *Rattus norvegicus norvegicus*, is known from Kansas and was named by Berkenhout (Outlines Nat. History Great Britain and Ireland, 1:5, 1769). The type locality is regarded as England.

Genus *Mus* Linnaeus

House Mouse

Mus musculus Linnaeus

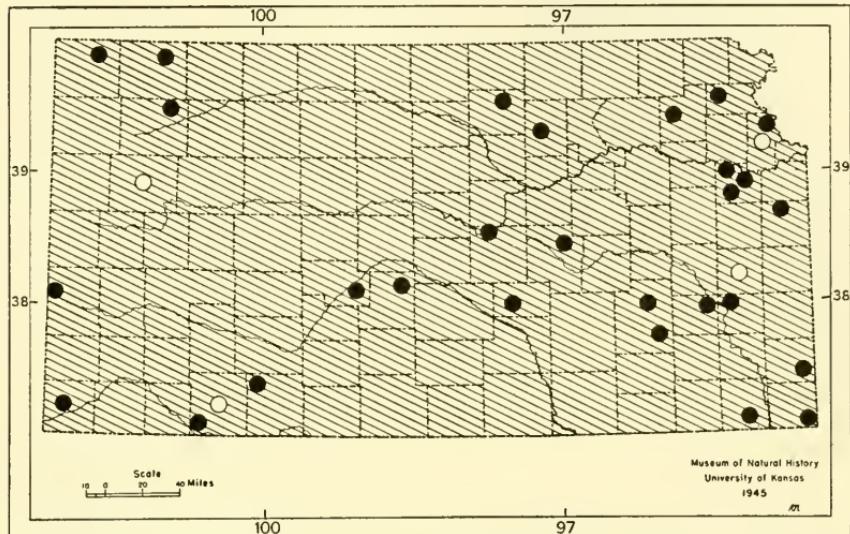
The House Mouse occurs throughout the State. Houses of man and other buildings are favored living places but in summer the House Mouse lives and reproduces in fence rows and fields. In mild winters many individuals live out of doors and never retreat to buildings. In some places where poisons have been used to eliminate the native mice, House Mice have invaded the vacated area and because they are highly prolific have rapidly multiplied and made real pests of themselves by damaging crops and food stuffs.

It is supposed that the House Mouse of Kansas is a mixture from stocks brought into the State at different times from different places. Two or more subspecies may be involved. One explanation that has been offered for the variation in coat color that is to be found in existing populations is that individuals of different subspecies have crossed. In some individuals the underparts are the same bluish gray as the back and sides; in others the underparts are paler.

Native species with which the House Mouse is most likely to be confused are the Deer Mouse, Woods Mouse, Western Harvest Mouse, and Plains Harvest Mouse. Compared with these, the House Mouse has a more scantily haired tail on which the annulated scales are more prominently revealed. Also if the upper incisor teeth be viewed from the side, the cutting face is seen to have a distinct notch that is lacking in the native species of mice. In cleaned skulls a readily perceived difference is the three rows of tubercles on the occlusal faces of the last three (molar) cheek-teeth; native mice have only two rows of tubercles, or the chewing faces of these teeth (in the Prairie Vole and its allies) are made up of two rows of lakes of dentine surrounded by thin walls of enamel.

Up to ten embryos have been found in one female and it seems that the House Mouse reproduces faster, under favorable conditions, than does any species of native mouse.

The well known white mouse used in laboratories is merely a color variety of the House Mouse. Many other colors of the pelage have been obtained by selective breeding of the House Mouse.



Description.—Total length, 130-198; tail, 63-102; hind foot, 16-21; occipitonasal length, 20.1-22.0; zygomatic breadth, 10.7-12.1. Upper parts brownish; underparts same color as upper parts or whitish; tail thinly haired and scaly; ears large and thinly clad with hair; tail never sharply bicolored and in some individuals no paler below than above; mammae in five pairs (3 pairs pectoral and 2 pairs abdominal); upper incisors smooth (not grooved) on anterior face; occlusal face of upper incisors notched; incisive foramina large and extending posteriorly to middle of first upper cheek-tooth; this tooth largest of the molars; longer than both second and third upper molars.

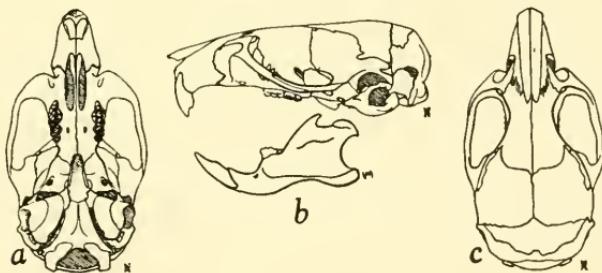


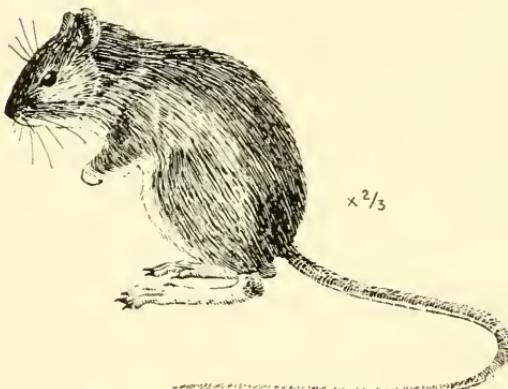
FIG. 48. Skull, and left lower jaw of House Mouse, *Mus musculus* subsp.?, Baker, 5800 ft., White Pine Co., Nevada, ♂, No. 41874 MVZ, $\times \frac{1}{2}$.

Several subspecies have been named in Eurasia but it is uncertain which of these are present in Kansas or elsewhere in North America.

FAMILY ZAPODIDAE

Genus *Zapus* Coues

Meadow Jumping Mouse

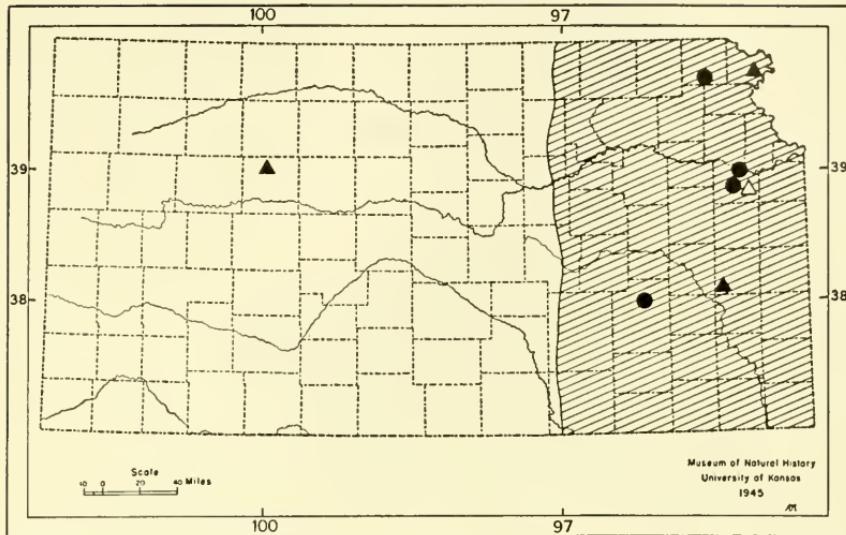
Zapus hudsonius (Zimmermann)

In this State the jumping mouse seems to occur principally where the native grasslands meet the native woodlands.

The relatively long hind legs and long feet enable the mouse to leap horizontally two to three feet at a bound. The long slender tail, a fifth longer than the head and body, is a balancing organ used while the mouse is leaping. The Meadow Jumping Mouse is principally nocturnal. In winter it hibernates and in late summer and early autumn accumulates much fat. For hibernation the mouse constructs a nest of grass, leaves or other vegetation in a burrow below ground in a well drained place. When hibernating, the mouse is rolled up in somewhat the same way that a watch spring is rolled up and rests "on edge" on the pelvis and top of the head.

The Meadow Jumping Mouse is primarily a vegetarian; it is said to feed more on the seeds of grass and on the seeds and fruits of other plants than on the green stems and leaves. A few insects are eaten.

There are from 2 to 8 embryos. Nests with 4, 5, 6 and 7 young have been found. The nests used in summer almost always are round structures lined inside with fine material, have an opening on the side, and are placed on the surface of the ground but are concealed under grass, weeds or rocks. At birth, young weigh only three fourths of a gram. Eyes open on the 22nd or 25th day. In the fourth week of life the pelage resembles that of the adults.



The Meadow Jumping Mouse has been found in the eastern fourth of the State and once was recorded from Wakeeney, Trego County, of western Kansas.

Description.—Total length, 178-204; tail, 106-121; hind foot, 26-29; ear from notch, 11-15; weight, 11.7-20.0 grams; greatest length of skull 21.0-22.7; zygomatic breadth, 10.5-11.8. Upper parts with broad mid-dorsal stripe, from nose to base of tail blackish, sparsely mixed with hairs of cinnamon buff; sides near cinnamon buff and sparsely mixed with black hairs except for band of pure color at margin of belly; underparts white or rarely suffused with buff; each upper incisor tooth with longitudinal groove on anterior face; four cheek-teeth on each side of upper jaw and three in lower jaw.

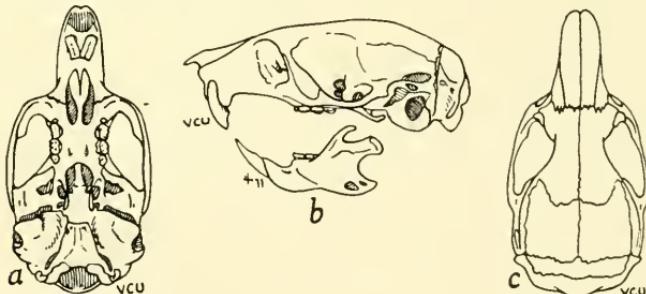


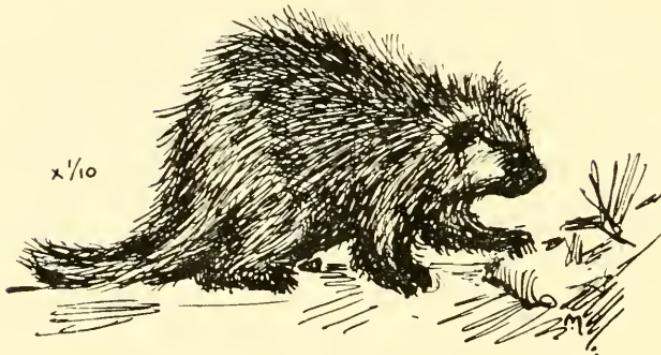
FIG. 49. Skull and left lower jaw of Meadow Jumping Mouse, *Zapus hudsonius* [subspecies *campestris* Preble], 3 mi. NW Sundance, 5900 ft., Crook Co., Wyoming, ♀, No. 20844 KU, $\times \frac{1}{2}$.

Zapus hudsonius pallidus is the only subspecies in the State and was named by Cockrum and Baker (Proc. Biol. Soc. Washington, 63:1, April 26, 1950) with type locality 5½ mi. N and 1¾ mi. E Lawrence, Douglas County, Kansas.

FAMILY ERETHIZONTIDAE

Genus *Erethizon* F. Cuvier

Porcupine

Erethizon dorsatum (Linnaeus)

The sharp stiff quills of the Porcupine are a defensive armament protecting this large rodent from carnivorous enemies. Hedgehog is a name sometimes applied to the Porcupine because the Hedgehog, an Old World mammal, also has quills. Actually, the Hedgehog is a relative of our mole and shrew and is not at all closely related to the Porcupine. The hair is of three kinds: (1) quills up to three inches long and a twelfth of an inch in diameter, white or yellowish-white except the distal 10 mm. that is black; (2) hair up to seven inches long, which is distally yellow, basally white, and black in the middle half (in an occasional animal the base also is black); (3) fur, in winter up to four inches long, black except for the basal third, which is white. In summer the fur is absent or so short that it can be found only by parting the spines and looking close to the skin. On the nose, cheeks posteriorly to the level of the eyes, chin, throat, and underside of the body the quills are lacking, the fur is shorter than elsewhere and the coarser hairs lack the distal yellowish-pigment and are all black.

The quills make painful wounds. Because they are loosely attached in the skin they remain in the victim that impales himself on them. The tip of a quill has backward projecting barbules that cause the quill to work on into the flesh of the unlucky recipient. Prompt removal of the quill by means of a strong pair

of pliers is the best treatment for any man or beast that has impaled himself. The Porcupine does not attack animals, even those that torment him, but does react by flipping the dangerous tail in the direction of a tormentor. Armed as it is with quills, the tail is capable of inflicting painful wounds. If quills on the tail happened to be loose, they probably would fall out or conceivably be thrown when the tail is flipped. If quills are thus dislodged it is understandable why some persons believe that Porcupines throw their quills.

Porcupines are fond of salt and this fondness causes them to gnaw axe handles, skirts of saddles, and any wood or leather that has absorbed salt from animal perspiration. The effective armor of quills may be one reason why the Porcupine shows slight if any fear at the approach of other animals. Although the Porcupine ordinarily moves away from a man by climbing a tree or ambling off, the animal at times shows not the slightest alarm at the presence of a man. For instance, one night, after my companion, Walter Mann, and I had lain down on the forest floor I awoke from what I imagined was an unpleasant dream of having a suffocating weight pressing down on my chest and discovered that a large Porcupine actually was sitting atop my blankets. Pulling the canvas over my face I then quickly tumbled the Porcupine off but in deliberate fashion he clambered right back again. Repeating the maneuver I arose before he had time to clamber atop my blankets a third time. With dead limbs gathered for fire wood we rained blows on the Porcupine that would have killed most animals his size and thus persuaded him to depart.

The rest of the story is that we had not dropped off to sleep again when the Porcupine set up a frightful racket by gnawing away on a greasy log inside an abandoned cabin a hundred feet or so distant. After a long period of hopeful waiting on our part gave no promise of his going elsewhere or of his gnawing on something less resonantly nerve-shattering, we arose and set out to do our worst by him—Walter with an axe and I with a burning pine knot to afford light. Walter did what had to be done. All this happened at approximately 8,000 feet elevation on the Kaibab National Forest in Arizona in the summer of 1925 but I have no reason to think that the Porcupine in Kansas is more wary of man.

The food ordinarily is the live inner layer of bark of a wide variety of trees. In spring and summer the Porcupine probably eats more herbaceous plants than bark.

The animal, in my experience, is more nocturnal than diurnal but it is a common sight to observe one moving about in the daytime. A Porcupine may remain in a single tree for several days. Some individuals, however, have dens in small caves in rock ledges and more or less regularly return to these dens for daytime retreats after feeding.

The female has one or two young. The quills are said to harden enough within a few hours after birth to afford protection for the young from most enemies.

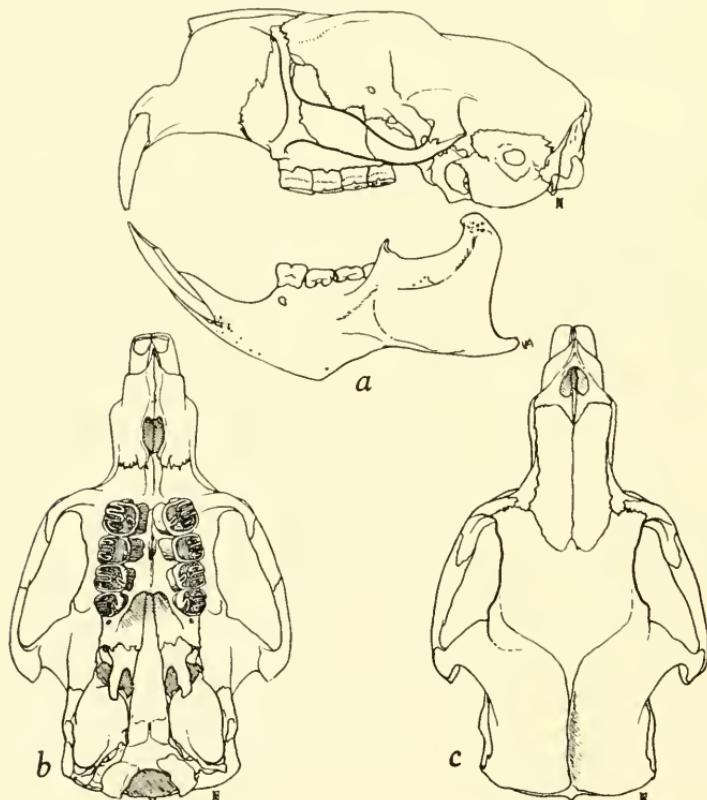
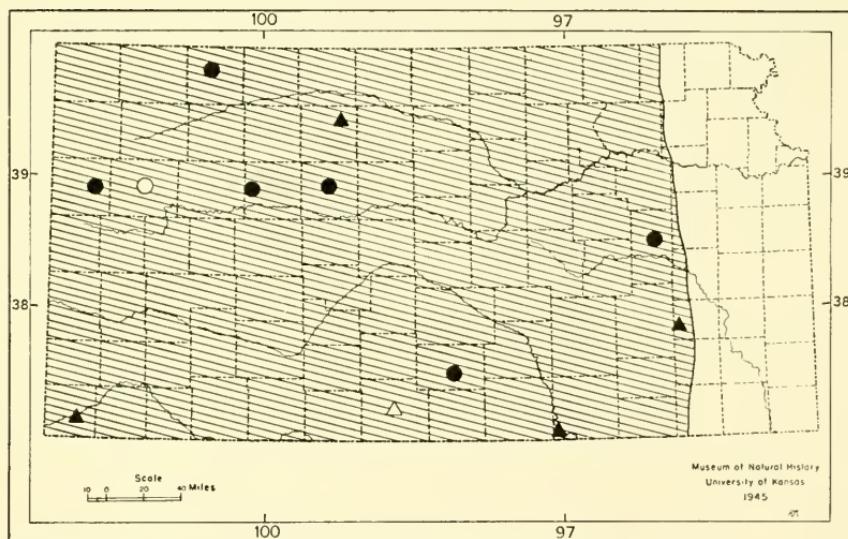


FIG. 50. Skull and left lower jaw of Porcupine, *Erethizon dorsatum* [subspecies *epixanthum* Brandt], Wilson Creek, 7200 ft., Nye Co., Nevada, ♂, No. 88223 MVZ, $\times \frac{1}{2}$.

One of the few natural enemies of the Porcupine is the Fisher. This large member of the weasel family does not occur in Kansas. There is some evidence, however, that individual Coyotes develop skill in killing Porcupines. Presumably the Coyote somehow turns the Porcupine on its back and attacks the underneath side which has but few spines. This is dangerous business for the Coyote; I remember in the California Museum of Vertebrate Zoology the dessicated head of a Coyote—seemingly a yearling—that was found dead with its mouth and face thickly studded with Porcupine quills. I surmise that the large number of quills prevented the animal from eating other food and caused his death by starvation. In Kansas, Man is the principal enemy and the Porcupine is rare in our state. Probably the Porcupine never was abundant in Kansas.



The Porcupine occurs now and then in all but the eastern sixth of Kansas and originally may have wandered into even that part of the State. The easternmost occurrences shown on the distribution map above are first ten miles north and eight miles east of Emporia and second, southwest of Toronto along the Verdigris River in Woodson County.

Description.—Total length, 630-785; tail, 180-215; hind foot, 70-105; weight, commonly 15 to 20 lbs.; basal length of skull, 90-91; zygomatic breadth, 64-71. Upper parts blackish or yellowish.

Erethizon dorsatum bruneri is the one subspecies in Kansas and was named by Swenk (Univ. Studies Nebraska, 16:117, November 21, 1916) with type locality three miles east of the town of Mitchell, Scotts Bluff County, Nebraska.

ORDER CARNIVORA

KEY TO CARNIVORES

1. Total length more than 1225 mm. (48 inches); tail less than 15 per cent of total length; M2 (always present) at least $1\frac{1}{2}$ times as long as wide.
 2. Longest claw on forefoot more than 55; last upper molar large (see figure 57). Grizzly Bear, page 186
 - 2'. Longest claw on forefoot less than 55; last upper molar small (see figure 58). Black Bear, page 191
- 1'. Total length less than 1225 mm. (48 inches); tail more than 15 per cent of total length; M2 (may be absent) less than $1\frac{1}{2}$ times as long as wide.
 3. Four toes on hind foot; 30, 32, or 42 teeth.
 4. Muzzle long and narrow; claws not retractile; 42 teeth including 2 upper molars on each side.
 5. In adults: weight less than 18 lbs.; total length less than 1050; greatest length of skull less than 175.
 6. Total length less than 735; upper parts buff-yellow Swift Fox, page 182
 - 6'. Total length more than 735; upper parts reddish or grizzled gray.
 7. Upper parts grizzled-grayish; tail with dorsal black stripe and prominently tipped with black; lyre-shaped temporal ridges; P2 approximately as long as wide. Gray Fox, page 184
 - 7'. Upper parts yellowish red; tail without dorsal black stripe and not tipped with black; temporal ridges not lyre-shaped; P2 approximately three times as long as wide. Red Fox, page 179
 - 5'. In adults: weight more than 18 lbs.; total length more than 1050; greatest length of skull more than 175.
 8. Diameter of nose pad less than 30 mm. ($1\frac{3}{16}$ inches); anteroposterior diameter of base of canine tooth less than 11.5 mm., Coyote, page 169
 - 8'. Diameter of nose pad more than 30 mm. ($1\frac{3}{16}$ inches); anteroposterior diameter of base of canine tooth more than 11.5 mm.
 9. In adults: weight ordinarily less than 68 lbs. in males and 52 lbs. in females; zygomatic breadth (in Kansas) less than 131 mm. in males and ordinarily less than 121 in females. Red Wolf, page 174

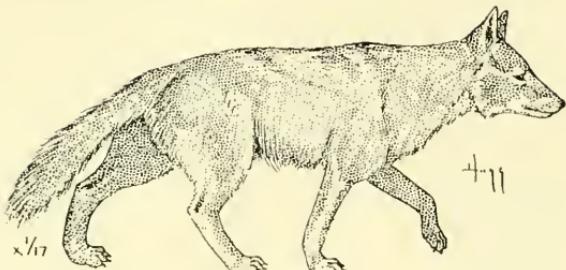
- 9'. In adults: weight ordinarily more than 68 lbs. in males and 52 lbs. in females; zygomatic breadth (in Kansas) more than 131 mm. in males and ordinarily more than 121 in females. Gray Wolf, page 176
- 4'. Muzzle short and wide; claws retractile; 30 or 32 teeth including only one upper molar on each side.
11. Tail more than 30 per cent of total length; three premolars on each side of upper jaw. Mountain Lion, page 220
- 11'. Tail less than 30 per cent of total length; only two premolars on each side of upper jaw. Bobcat, page 224
- 3'. Five toes on hind foot; 34 to 40 teeth.
12. Pelage of tail with conspicuous rings; 40 teeth.
13. Black rings on tail complete all around, numbering usually six not counting black tip; tail, excluding hair at tip, near $\frac{1}{3}$ of total length; posterior margin of bony palate extending behind last molars for a distance of more than combined lengths of M1 and M2. Raccoon, page 194
- 13'. Black rings on tail incomplete, being absent on ventral side, numbering usually eight not counting black tip; tail, excluding hair at tip, near $\frac{1}{2}$ of total length; posterior margin of bony palate on a line with last upper molars, or extending behind them for a distance of less than combined lengths of M1 and M2. (no actual wild-taken specimen from Kansas is yet in any Museum collection) Ring-tailed Cat, page 246
- 12'. Pelage of tail without conspicuous rings; fewer than 40 teeth.
14. Upper parts some shade of brown, buffy yellow, or silvery, never predominantly black and white; border of bony palate at least as far behind last upper molars as the length of an upper molar.
15. Total length of adults more than 840 (33 inches); hair on tail approximately same length as on back; 36 teeth; P4 with deutocone expanded into a basined structure. River Otter, page 217
- 15'. Total length of adults less than 840 (33 inches); hair on tail longer than on back; 34 teeth; P4 with simple deutocone, not expanded into a basined structure.

16. Color of upper parts silvery, with a single white stripe on middle of head extending a varying distance toward the tail; basilar length of skull more than 80 mm.
..... Badger, page 204
- 16'. Color of upper parts some shade of brown or buffy yellow; basilar length of skull less than 80 mm.
17. Upper parts yellow; feet and (mask on) face darker (black) than back; least interorbital breadth more than 16.5 mm., Black-footed Ferret, page 202
- 17'. Upper parts brown; feet and face not darker than back; least interorbital breadth less than 16.5 mm.
18. Abdomen dark brown, like back; length of upper tooth-rows more than 20 mm. in males and 17.8 in females Mink, page 197
- 18'. Abdomen white or light yellow, paler than back; length of upper tooth-rows less than 20 mm. in males and 17.8 in females.
19. Tail with distinct black pencil including tip; hind foot more than 32 mm.; mastoid breadth of skull more than 17.2 mm.
..... Long-tailed Weasel, page 199
- 19'. Tail without a black pencil and with at most a few black hairs at extreme tip; hind foot less than 32 mm.; mastoid breadth of skull less than 17.2 mm.
..... (not yet taken in Kansas) Least Weasel, page 246
- 14'. Upper parts black and white; border of bony palate approximately on a line with posterior edges of last upper molars (never so far posterior to that line as the length of an upper molar).
20. Back all black or with white stripes (or lines of white spots) separated by black; 4 cheek-teeth in upper jaw behind canine tooth.
21. Back all black or with two white stripes; first lower molar longer than 8 mm.
..... Striped Skunk, page 208
- 21'. Back with four or more lines of broken stripes or spots; first lower molar shorter than 8 mm.
..... Spotted Skunk, page 214
- 20'. Back all white; 3 cheek-teeth in upper jaw behind canine tooth
..... (not yet found in Kansas) Hog-nosed Skunk, page 246

FAMILY CANIDAE

Genus *Canis* Linnaeus

Coyote

Canis latrans Say

The Coyote is the largest carnivore remaining in Kansas. Its size is approximately that of a Collie Dog but the Coyote is at once recognizable as a wild animal by reason of its erect ears, less elevated tail, alertness and "lightness of foot." The weird and characteristic voice of the Coyote is a mixture of barks and howls and is familiar to almost everyone who has spent much time outside of a city. Coyotes are more likely to be heard shortly after nightfall than at any other time.

This is the smallest of the three North American species of wolves all belonging to the Genus *Canis*. The Gray Wolf, *Canis lupus*, is the largest and the Red Wolf, *Canis niger*, is intermediate in size. The vernacular names have been loosely applied, however, and the names "Western Wolf," "Wolf" and "Prairie Wolf" all have been applied to the Coyote. Price lists mailed to trappers by buyers of raw furs in some years have used the name "Prairie Wolf" to apply to all or some grades of Coyote pelts and thus there has been some confusion in the popular mind concerning the proper application of the word wolf. There has been some confusion also about the proper pronunciation of the word Coyote. In the eastern United States the word ordinarily is pronounced kī ōt. That is to say, the final e is silent. In the western United States and Mexico the e is sounded and the pronunciation is kī-ō' tē. If a rule is desired, shall we say that the name is pronounced as kī ōt anywhere east of the city limits of Dodge City and as kī-ō' tē west thereof. The word was adopted by the New World Spanish people from the Nahuatal Indians who spoke of the animal as Coyotl.

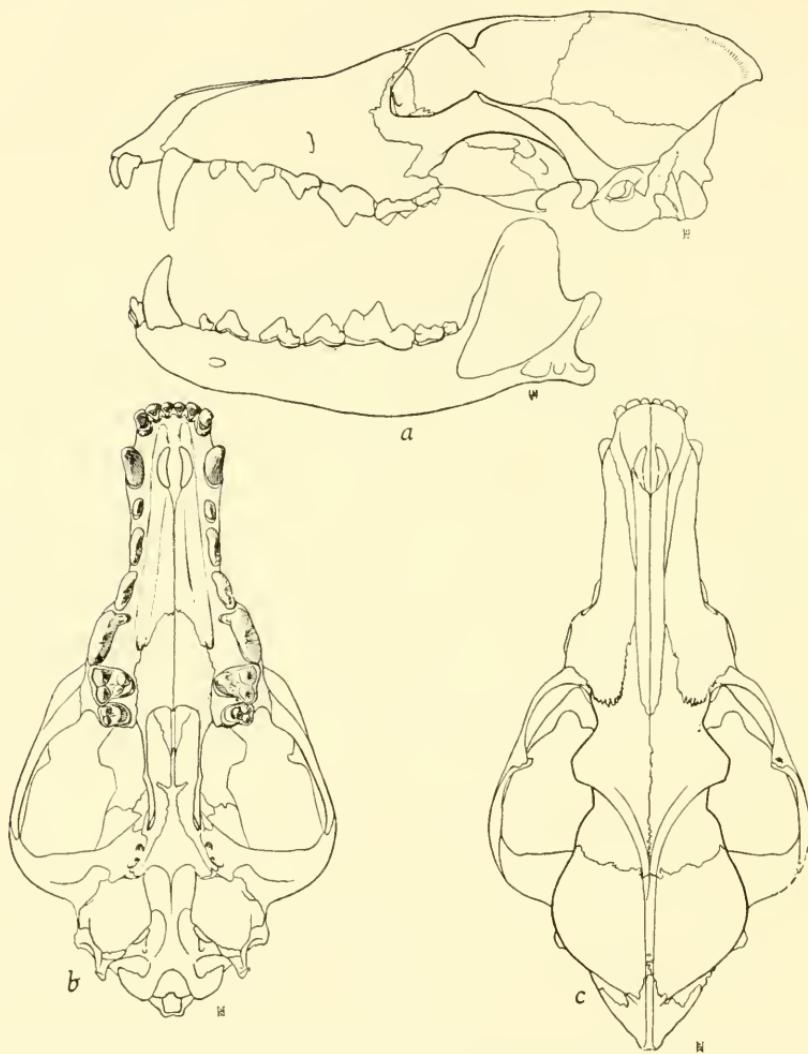


FIG. 51. Skull and left lower jaw of Coyote, *Canis latrans* [subspecies *lestes* Merriam], 5 mi. S Fallon, Churchill Co., Nevada, ♂, No. 89940 MVZ, $\times \frac{3}{5}$.

The food is roughly a third rabbits, a fourth carrion, a fifth rodents, a fiftieth vegetable matter and the remainder various kinds of animals. Individual Coyotes take to preying on lambs, poultry and little pigs; even calves have been reported as killed by such renegade Coyotes.

The male shares with the female the task of feeding the young, of which there is one litter per year born in the spring after a gestation period of 60 to 63 days. The young average approximately

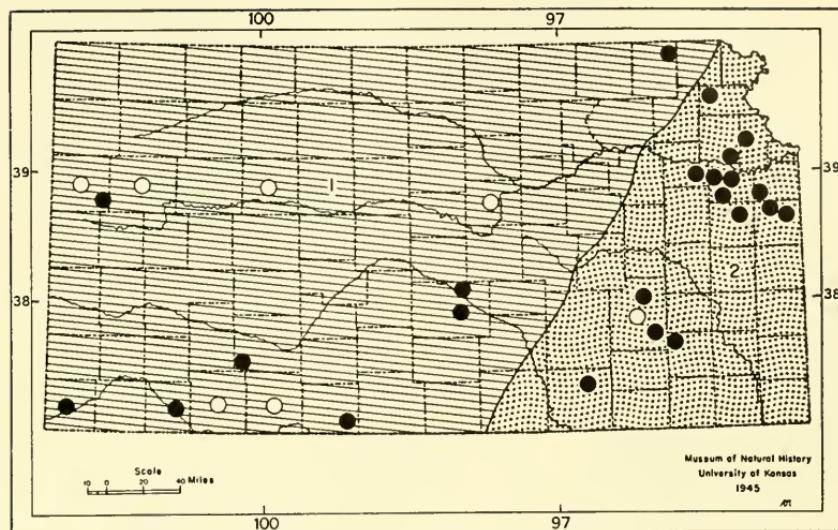
seven to a litter. They are born in a den which usually is dug in the ground. There is no nest. The eyes open on the ninth to the fourteenth day of life. The young come out of the burrow when they are approximately three weeks old but do not abandon the den until they are 8 to 10 weeks old. The voices of the young are thinner-toned than those of adults. Adults yelp at any time of year but are more prone to do so in the breeding season than at other times. Up to eight individuals have been seen together in the breeding season; otherwise they live singly, in pairs or in family groups.

In some years, when long-haired furs are in fashion, Coyote pelts sell at good prices (\$8.00 to \$17.00) but in most years bring a lower price and in years when long-haired furs are not in style the fur value is slight.

Kansans are divided in their opinion of the Coyote; some commend and some condemn him. Farmers who believe that he benefits them, for example by locally destroying or reducing the population of field mice in legume plantings, commend the Coyote. Farmers who believe that he harms them in some way, for example by locally killing poultry or livestock, condemn him. Biologists who study the Coyote on a state-wide basis conclude that both beliefs are justified; that is to say, the Coyote can be harmful or beneficial to Man, depending on the time and the place.

In Kansas the population of Coyotes fluctuates; after reaching a peak in abundance the population declines in two to four years to a low point and then an increase sets in again. Where it has been decided to decrease the numbers by artificial means, many methods have been tried of which the following are some: (1) catching in steel traps; (2) shooting from horseback, automobiles or aeroplanes; (3) poisoning; (4) den hunting before the young are old enough to leave the burrows; (5) capturing by dogs; (6) capturing by organized drives by armed persons converging on a central point; (7) "shooting" with a cyanide gun, a set-gum, buried in the ground, which discharges cyanide dust into the Coyote's mouth when he tugs at a tuft of rabbit fur that has been doused with a scent attractive to the Coyote; (8) offering bounties; (9) applying the so-called "State system of control," which provides two skilled trappers (biologists) who demonstrate, as need arises, to interested farmers and ranchers the simple trapping procedures that are of known effectiveness in eliminating the individual Coyote that is causing the damage.

Proponents claim that where public funds are deemed necessary to control Coyotes, the "State System" is far more economical than any other, that it is effective in quickly eliminating the individual Coyote which is causing damage, and that it encourages the land-owner or tenant to help himself; if he suffers enough damage to warrant relief he easily acquires the "know-how" to obtain relief himself and no tax levy is required to set up a sizable group of governmental employees. Such a group of employees tends to spend time and money in building up a demand for their services in order to have more work to do and the effects of the poisons that they use cause much objection from citizens. Where the State System has been tried, it, on the contrary, is said to have given satisfaction. It has been claimed that the adoption by all states of the "State System" would result in several hundred positions on the federal payroll being eliminated—those positions set up for federal employees who are widely distributed over the western United States in late years to kill Coyotes principally by distributing poisoned baits. In the long run, agriculture suffers from the use of these poisons, it is said, because the balance of nature is upset in such a fashion as to bring, in turn, bigger and more expensive programs to control the smaller pests that get out of hand, because their natural enemies (Coyotes and other flesh eating animals) have been eliminated. Although this statement may be too simple, or not wholly correct, it certainly is true that some interests and individuals (including farmers, dog owners, hunters, conservationists and others) raise objections or make claims for damages where poison is used. Many students of government, of natural resources, and of agricultural practices think that the federal function is only to experiment and recommend; they favor the State System because of its economy and because it does not destroy harmless and beneficial wild life. At any rate, the Coyote because of its high rate of reproduction, adaptability, and cunning tends to persist in spite of efforts to exterminate it. Also, unless care is exercised to select the proper means of control, valuable species will be exterminated before the numbers of the Coyote are much reduced.

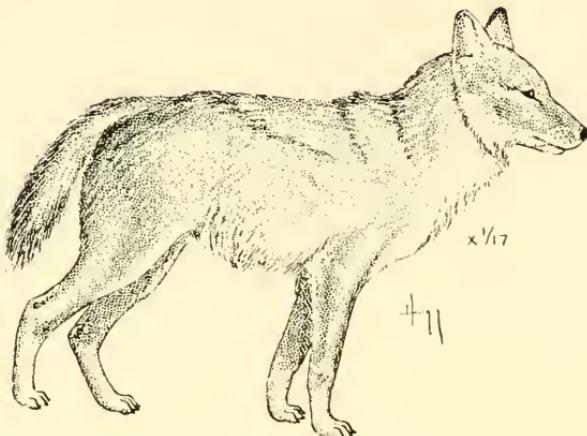


Distribution of *Canis latrans*.
1. *Canis l. latrans*. 2. *Canis l. frustror*.

Description.—Total length, 1041-1295; tail, 267-380; hind foot, 169-212; ear from notch, 102-116; weight, 22 to 35 lbs.; condylobasal length of skull, 163.7-203.5; zygomatic breadth, 89.0-112.8. Females average smaller than males by five per cent in linear measurements and by approximately fifteen per cent in weight. Upper parts buffy gray lined with black; underparts pale buff; pelage fading to a paler more yellowish color in summer than in winter; eye round with yellow iris; mammae 10; one molt per year. Two distinctions from the true wolves are: heel pad of forefoot less (instead of more) than 1½ inches; anteroposterior diameter of base of canine tooth less (instead of more) than 11.5 mm. For other differences see account of Red Wolf on page 184.

The two subspecies in Kansas are *Canis latrans latrans* of western Kansas named by Say (*in S. H. Long and E. James Expedition to the Rocky Mountains*, 1:168, 1823) with type locality at "Engineer Cantonment," approximately 12 miles southeast of the present town of Blair, Washington County, Nebraska, on the west bank of the Missouri River and *Canis latrans frustror* of eastern Kansas named by Woodhouse (*Proc. Acad. Nat. Sci. Philadelphia*, 5:147, June 30, 1851) with the type locality on the Red Fork [now the Cimarron River] of the Arkansas River probably near 97° West Longitude in the vicinity of the present town of Perkins in Payne County, Oklahoma, approximately 100 miles west of Fort Gibson, Oklahoma.

Red Wolf

Canis niger (Bartram)

The Red Wolf probably occurred in Cherokee County, the southeasternmost County of the State, as late as 1909 (see Cockrum, Univ. Kansas Publ., Mus. Nat. Hist., 7:229, August 25, 1952). Formerly this species ranged throughout the southeastern United States, but the animal has been killed out in large areas of this region. Rabbits are reported to constitute the principal food.

No specimen taken in Kansas is in any museum. Any exceptionally large 'coyote' caught in southeastern Kansas would be welcome at the University on the chance that the animal might prove to be a Red Wolf.



Description.—Total length, 1403, 1454; tail, 381, 420; hind foot, 210, 221. The measurements are of two males from Redfork, Oklahoma. A male from Noble, Oklahoma, weighed 55 lbs. Measurements of the skulls of two males and two females, from "the vicinity of" Llano, Texas, are: Condyllobasal length, 207.8, 209.0, 200.9, 207.3; zygomatic breadth, 117.5, 112.3, 106.0, 110.2. Upper parts tawny, cinnamon or cinnamon-buff with gray and black; muzzle, ears and outer sides of legs tawny; underparts whitish or pinkish buff; tail tipped with black; some animals predominantly black. The Red Wolf is larger than the Coyote and smaller than the Gray Wolf.

The Red Wolf (and also the Gray Wolf) is distinguished from the Coyote as follows: Diameter of nosepad more (instead of less) than $1\frac{3}{16}$ inches; diameter of heel pad of forefoot more (instead of less) than $1\frac{1}{4}$ inches; antero-posterior diameter of base of canine tooth more (instead of less) than 11.5 mm.; when skull with lower jaws in place is viewed directly from in front, tips of upper canine teeth are above (instead of below) a line connecting the two anterior mental foramina of the lower jaws.

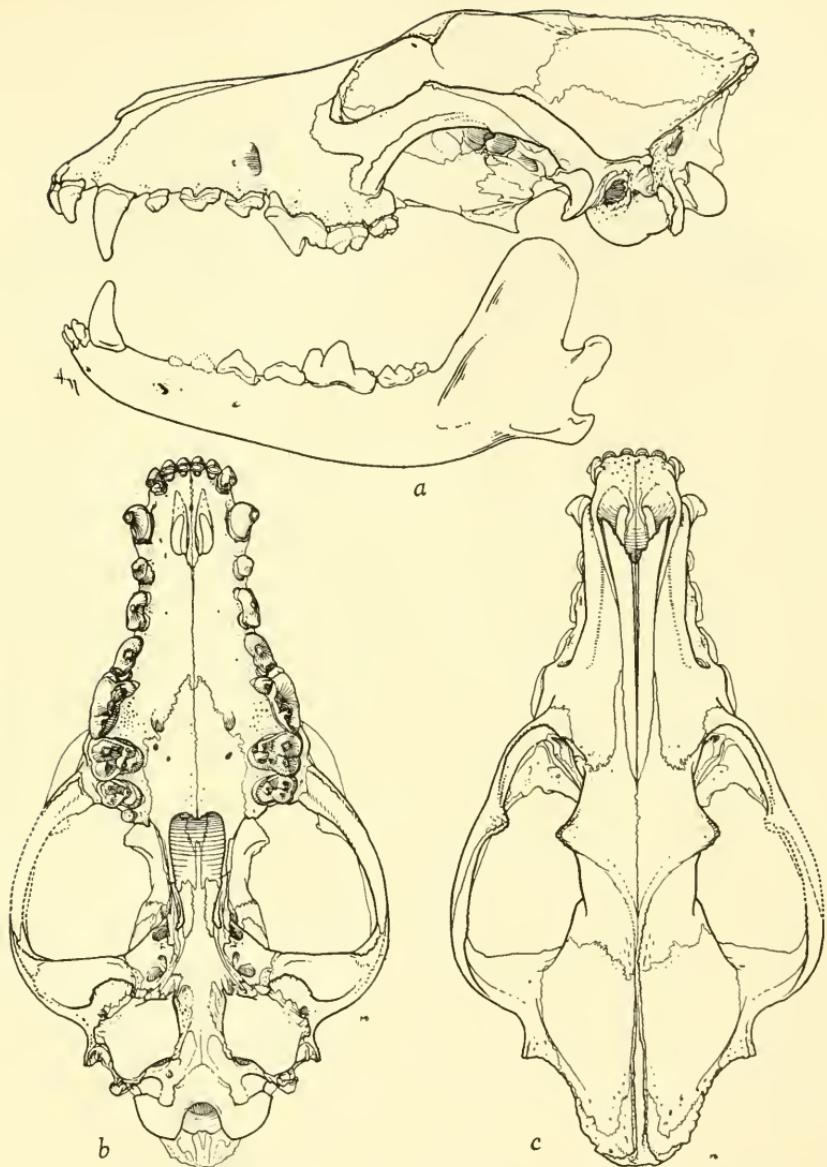
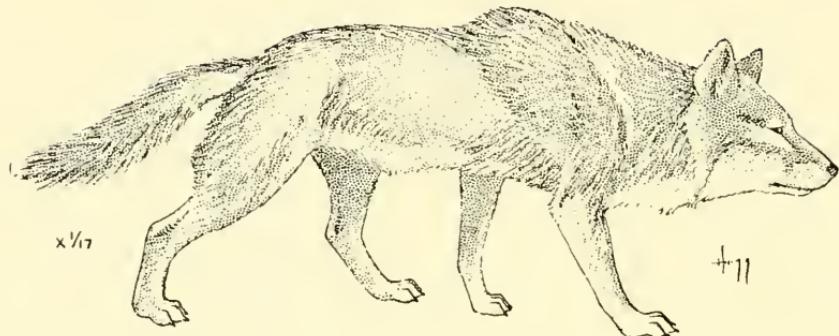


FIG. 52. Skull and left lower jaw of Red Wolf, *Canis niger gregoryi* Goldman, south of Cremona, Polk Co., Texas, ♀, No. 95809 MVZ, $\times \frac{2}{3}$.

For want of specimens to study so as to prepare a formula useful in differentiating Red Wolves from Gray Wolves, the best information that I can give on this matter at this time is contained in the key on pages 166, 167.

Canis niger rufus is the subspecies that is thought to have occurred in Kansas and was named by Audubon and Bachman (*Quadrupeds of North America*, 2:240, 1851) without designation of a precise type locality.

Gray Wolf

Canis lupus Linnaeus

The Gray Wolf, now extirpated in Kansas, is the largest of the three North American species of wolves, all belonging to the genus *Canis*. The vernacular names Gray Wolf, Wolf, Timber Wolf, Big Gray, and Lobo have been applied to it. For the Red Wolf, some of the same names have been used. For the Coyote the names, Wolf, Western Wolf and Prairie Wolf have been used. It is no wonder, therefore, that confusion exists in the minds of many persons as to the proper terminology. It seems best to refer to *Canis lupus* as the Gray Wolf, to *Canis niger* as the Red Wolf, and to *Canis latrans* as the Coyote.

Speaking now of the Gray Wolf, it occurred all across Eurasia and North America. J. R. Meade, an early hunter, trapper and resident of Kansas in recording some natural history notes for the year 1859, wrote (*Transactions Kansas Academy of Science*, volume 16, pages 280-281, 1899) that: "Lobo, the mountain wolf, locally known on the plains as 'big gray,' were congeners and associates of the buffalo, and lived almost exclusively upon them Hunters with strychnia finally exterminated the wolves, myself and men killing some 5,000 of them. They never molested people."

Any kind of flesh seems to have been acceptable as food. Dens for rearing young were in natural cavities and in burrows in the ground. The gestation period is 62 to 66 days; the young are born ordinarily between March 9 and April 15. A litter has 3 to 13 pups, six, seven or eight being common numbers.

The Gray Wolf crosses with domestic dogs and the resulting offspring are fertile. For that matter the Red Wolf has been known to cross with a dog and I know of more than one instance of a cross between the Coyote and dog. Crosses, however, are more common between dogs and the Gray Wolves than between dogs

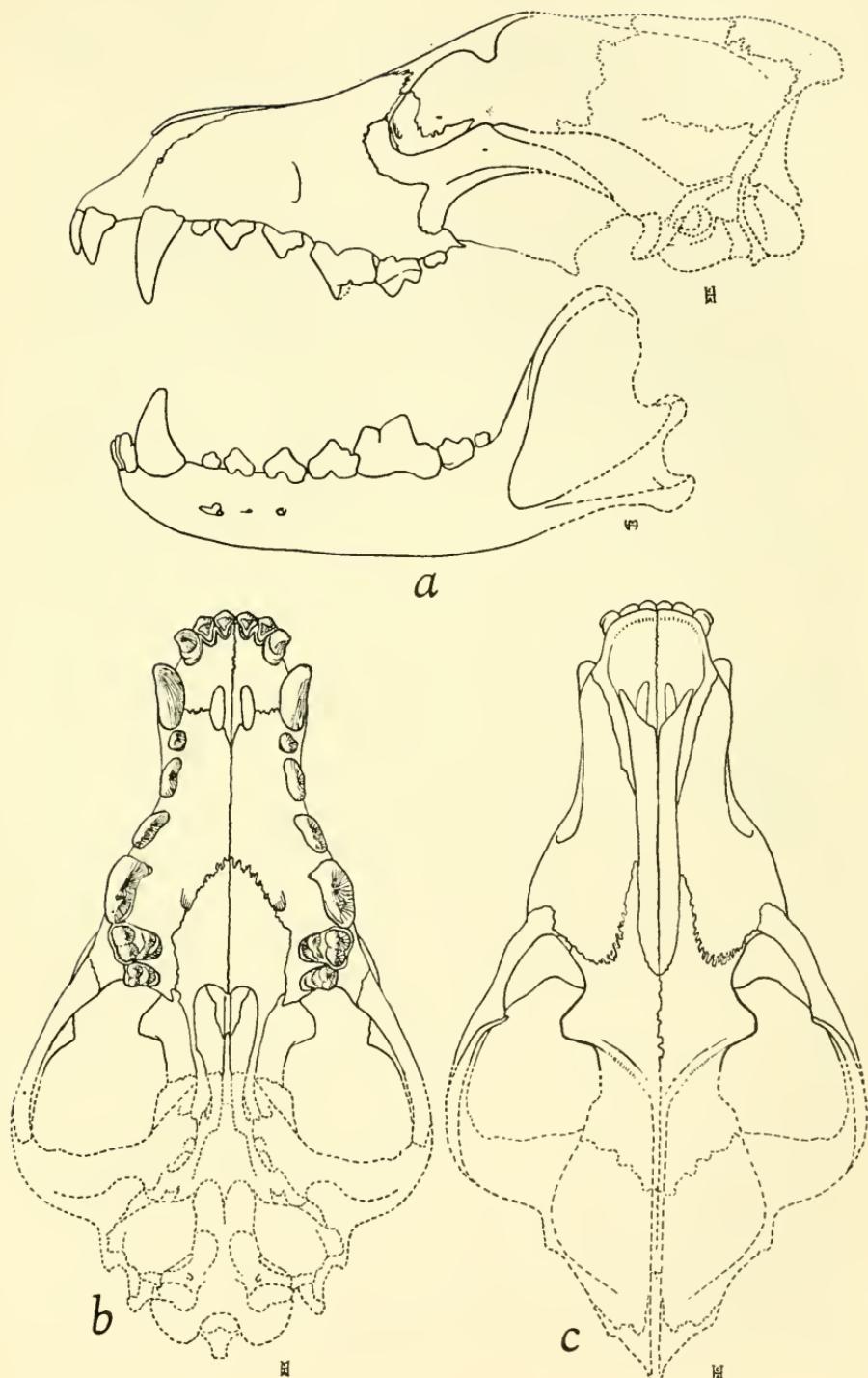
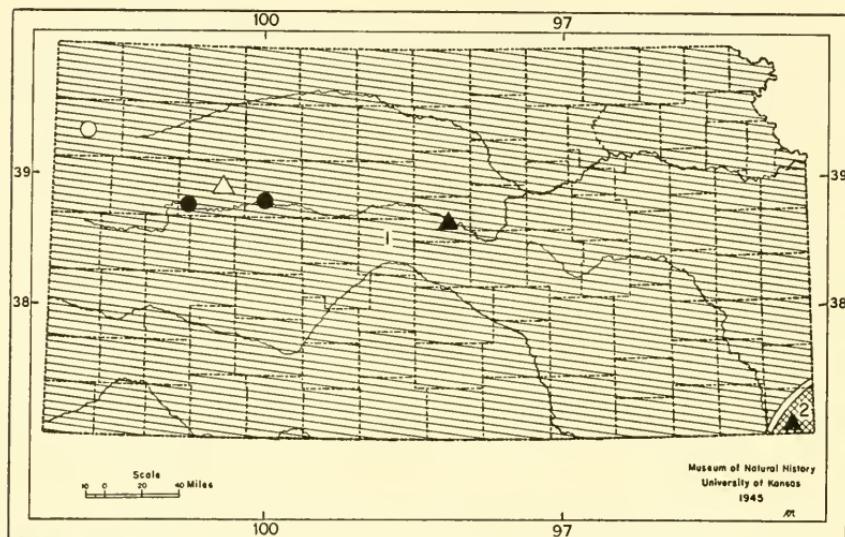


FIG. 53. Skull and left lower jaw of Wolf, *Canis lupus* [subspecies *youngi*] Goldman, Gold Creek, Elko Co., Nevada, ♂, No. 33428 MVZ, $\times \frac{3}{5}$.

and the Red Wolves or dogs and Coyotes. The animals that are crosses between Gray Wolves and dogs work well on the trace and even some full-blooded Gray Wolves have been successfully used as sledge dogs.



Distribution of wolves.
1. *Canis lupus*. 2. *Canis rufus*



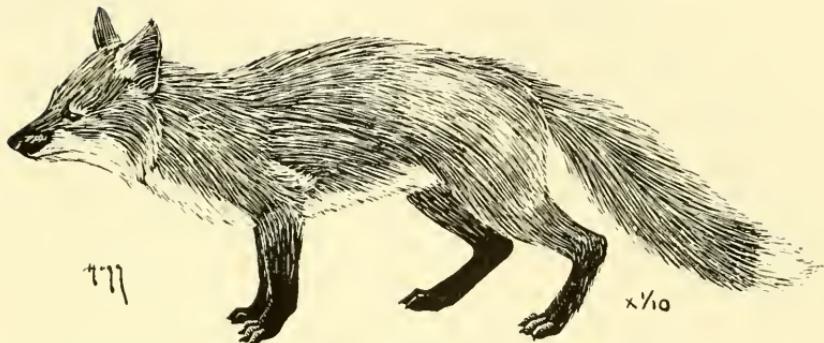
Description.—An adult male from Douglas, Wyoming, measured 1982 in total length. The tail would have measured approximately 420, and the hind foot 285. The ear is relatively shorter than in the Coyote. Weights of full grown adults on the Great Plains were said to be in the order of 125 pounds for males and 100 pounds for females; however, some, I think, were smaller. Greatest length of skull, male 243.7-264.5, female 222.0-250.5; zygomatic breadth, male 132.4-145.1, female 119.4-135.1. Upper parts ordinarily gray resulting from mixture of white and light buff overlaid with some black; underparts white to pale pinkish buff; wolves nearly white and some that are black may occur in the same litter along with normally-colored individuals.

A Gray Wolf ordinarily is twice, or more, as heavy as a Coyote, has relatively shorter ears, a more heavily proportioned skull, a relatively wider foot, and a heel pad on the forefoot that is broader, instead of narrower, than one and one-fourth inches. Other differences between the Gray Wolf (and also the Red Wolf) on the one hand and the Coyote on the other hand are noted on page 174 in the account of the Red Wolf. Distinctions between the Gray Wolf and the Red Wolf are less trenchant; see key on pages 166 and 167.

Canis lupus nubilus is the Kansas subspecies. Say (Long's Expedition Rocky Mountains, 1:169, 1823) named it with type locality at the Engineer Cantonment, near the present town of Blair, Washington County, Nebraska.

Genus *Vulpes* Oken

Red Fox

Vulpes fulva (Desmarest)

The Red Fox ordinarily lives where patches of timber alternate with pastures and cultivated fields. Perhaps this fox is our handsomest mammal; certainly its bright red color, huge tail with a white tip, and graceful carriage make it an unusually attractive creature. The Red Fox was native to the northern and northwestern parts of North America when White Men arrived but there seems to have been none in the eastern half of the United States south of the latitude of Pennsylvania. It is alleged that Red Foxes were brought from England and liberated on Long Island, New York, and spread from there to the mainland. Now the Red Fox is well established over most of the eastern half of the United States. Careful studies of the structure might, or might not, reveal if our Red Fox is the European strain, a native strain, or a hybrid of the two. Some persons think that sportsmen interested in fox hunting, especially those who rode to hounds, released Red Foxes in several regions where they previously were absent or rare. Whatever the facts be in this respect, the Red Fox is well established now in the Kansas River Valley in the vicinity of Lawrence, and in several other parts of eastern Kansas, but is nowhere so abundant as it seems to be in more eastern states, for example in parts of Missouri and Ohio.

Sly as a fox is a saying that has a basis in the success enjoyed by the Red Fox even in thickly settled communities. The strategems employed by the Red Fox in making his trail difficult for hounds to follow are numerous and demonstrate a versatility and probably a cunning that surpasses that of most wild mammals.

In Kansas the animals of this species, so far as I have learned, all are red. To the north and west, there are three other color phases. The black was the rarest of these. The silver fox was slightly more common. The cross fox is reddish brown with heavy black markings. The red fox, cross fox, silver fox and black fox are not different

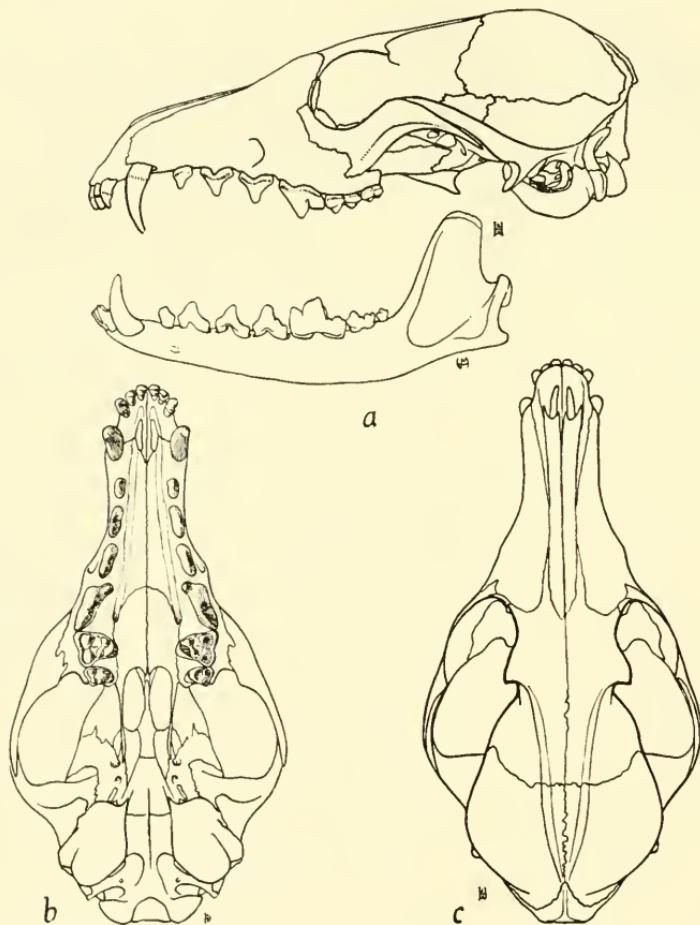


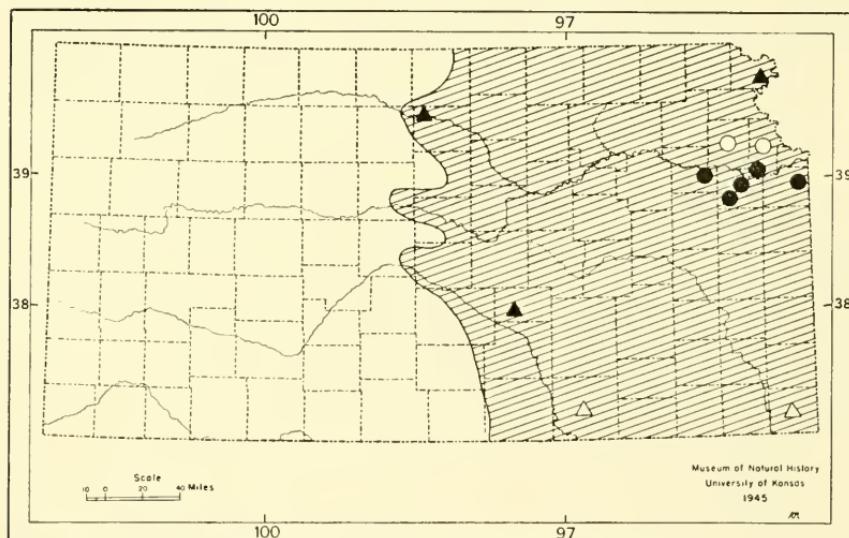
FIG. 54. Skull and left lower jaw of Red Fox, *Vulpes fulva* [subspecies *necator* Merriam], Marlette Lake, 8000 ft., Ormsby Co., Nevada, ♂, subadult, No. 69636 MVZ, $\times \frac{1}{2}$.

species but merely color phases; two or three or all four of the color phases can occur in a single litter from the same pair of parents. This is the species of which so many are raised in captivity for their fur. By selective breeding many variants of the four color phases mentioned above have been produced for the market.

Small mammals are the principal food of the Red Fox. Mice constitute the larger part.

Except in the past few years when long-haired furs have been out of fashion and the price was low, the Red Fox was one of our valuable furbearers. Also it shares with the Raccoon, in states from Missouri eastward, top position among sportsmen who follow hounds. Nevertheless, in Kansas, except in the extreme eastern part, there has been no fox hunting in the traditional fashion. The species seems to be extending its range westward in Kansas; anyhow it is appearing in central Kansas where it was unknown before.

The gestation period is 51 days. The young, 4 to 9 in a litter, are born in a burrow, usually in the ground. The eyes open on the 9th day. The young emerge from the burrow and play about the entrance when only three to four weeks old. They continue to occupy the den until about three months of age.



Waconda Springs in Mitchell County and "near" Halstead in Harvey County are the two westernmost record stations of occurrence.

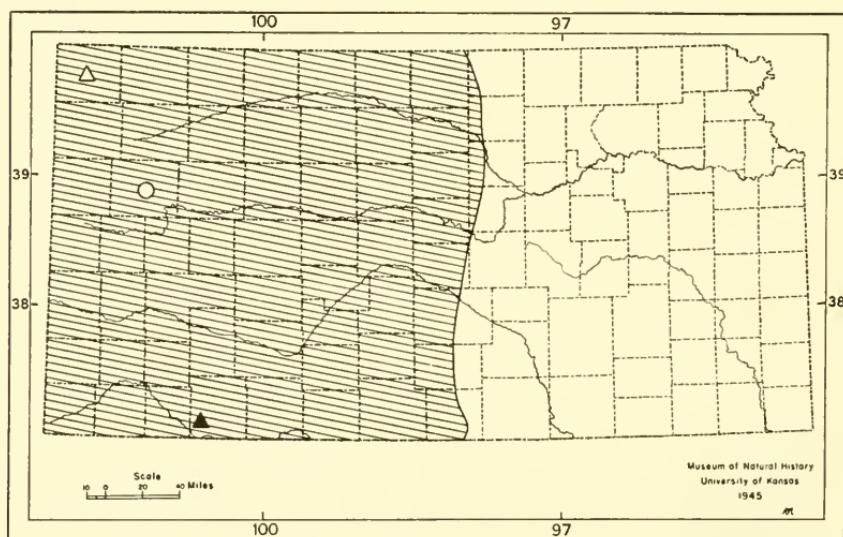
Description.—Total length, 910-1000; tail, 310-357; hind foot, 145-160; weight 10½ lbs.; basilar length of skull, 120.0-134.2; zygomatic breadth, 70.0-77.2. Upper parts red; muzzle, neck and shoulders tawny orange; flanks, rump and tail golden brown; legs and ears black; insides of ears, cheeks, throat, tip of tail and underparts white.

Vulpes fulva fulva is the only subspecies in Kansas and was named by Desmarest (*Mammalogie*, 1:203, 1820) with the type from Virginia.

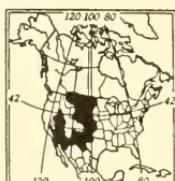
Swift Fox

Vulpes velox (Say)

The Swift Fox was almost extirpated in Kansas. It lives on the prairie in pairs the year round and each pair has a burrow. One den in Colorado was nine feet long and five feet below the surface. The unsuspecting nature of this fox causes it to be one of the first victims of poisoned baits, that originally were distributed to kill



Description.—Total length of 660, tail of 230, hind foot of 100, ear from notch of 60, are approximate measurements. Four and a half pounds and five pounds ten ounces are recorded weights of two individuals. Basilar length of skull, 99.4-99.7; zygomatic breadth, 68.5. Upper parts buffy yellow; tail buffy gray, tipped with black; underparts whitish; blackish spot on each side of muzzle.



Gray Wolves and that in later times have been used for the purpose of killing Coyotes. The food is described as chiefly mice.

The Kit Fox, *Vulpes macrotis*, which occurs to the west of the Rocky Mountains, is the closest relative of our Swift Fox. The two foxes may be only subspecifically different. Specimens from New Mexico, where their ranges met, would be required to determine this point. All foxes in the critical area may have been destroyed by poison intended for the Coyote. At each of several Kit Fox dens at Dugway, Utah, in 1955, I found one to three gallons of feces composed of hair and bones of desert rodents.

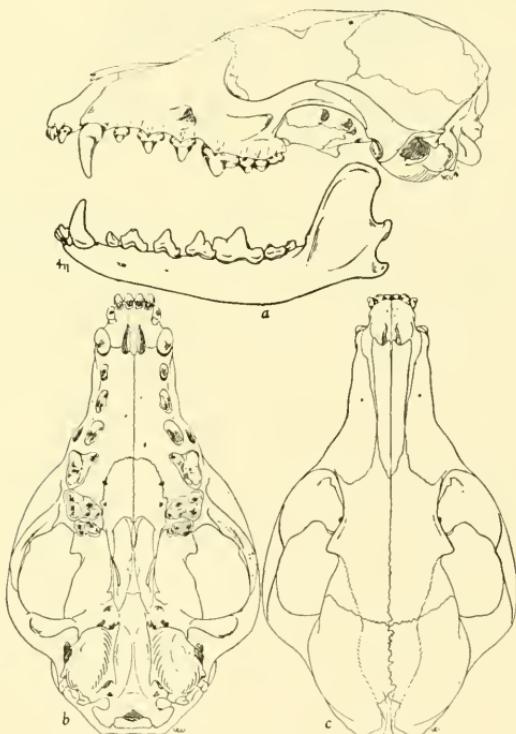
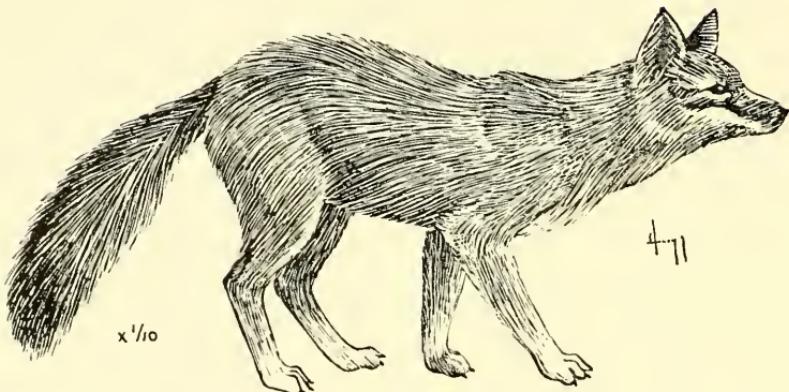


FIG. 55. Three views of skull and left lower jaw of Swift Fox, *Vulpes velox* (Say), First View, Cheyenne Co., Colorado, ♂, No. 1601 KU, $\times \frac{1}{2}$.

Vulpes velox velox is the subspecies that occurs in Kansas. It was named by Say (Long's Expedition, Rocky Mountains, 1:487, 1823) with type locality along the South Platte River of what is now the state of Colorado.

Genus *Urocyon* Baird

Gray Fox

Urocyon cinereoargenteus (Schreber)

In the eastern third of Kansas the Gray Fox lives in timber having tangles of brushy cover, climbs trees (even vertical trunks, 20 or more feet to the first limb, that are up to 18 inches in diameter), is omnivorous but eats animal food when available, often lives in dens in rock ledges or in hollows in trees, and has three to five young in a litter. Gray Foxes lived in Douglas County from 1950 to date (1955) but reportedly were rare or absent in the preceding 50 years.



The three westernmost record stations of occurrence are 8 mi. E State Capitol Bldg. in Shawnee County, 8 mi. NE Hamilton in Greenwood County, and a point 5 mi. W and 3 mi. S Arkansas City in Cowley County.

Description.—External measurements and weight of a male approximately 10 months old from 8 mi. E Topeka State House, Shawnee County, are: total length, 943; tail, 354; hind foot, 141; ear from notch, 74; weight, 8½ lbs. Basilar length of skull (of other specimens), 104.5-116.6; zygomatic breadth, 68.5-72.3. Upper parts gray with buffy color showing through; ears, sides of head, and neck and legs, brownish orange; flanks, insides of legs, anal region and underside of tail paler brownish orange; insides of ears, cheeks, throat and underparts white; sides of muzzle, chin and mane on tail black; tip of tail black. The black mane on the midline of the top of the tail is made up of stiff, coarse black hair and grows from an area 3 to 4½ inches long. In the skull, two distinctive features are first the step in the inferior margin of the lower jaw midway between the angular process and the anterior border of the coronoid process and second the lyrate pattern of the temporal ridges on the top of the skull.

Urocyon cinereoargenteus ocythous is the subspecies in Kansas and was named by Bangs (Proc. New England Zool. Club, 1:43, June 5, 1889) with type locality at Platteville, Grant County, Wisconsin.

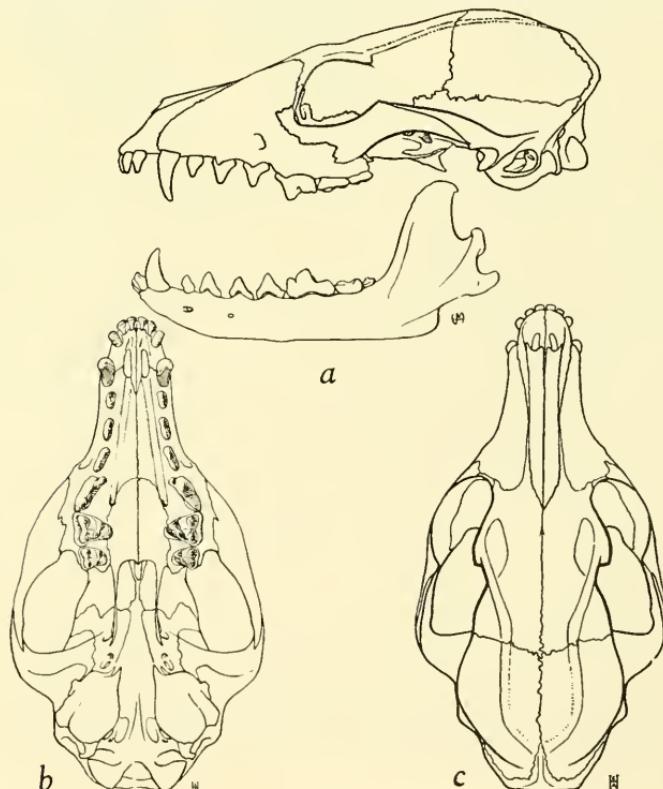
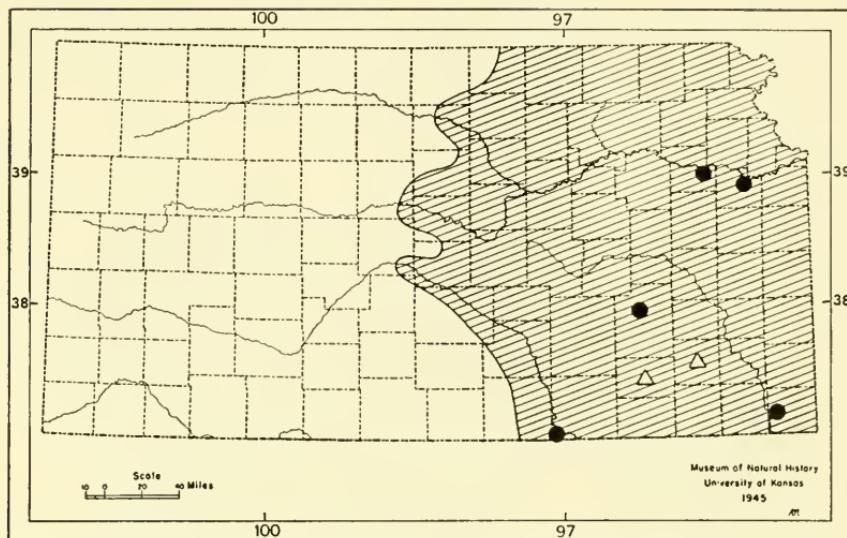
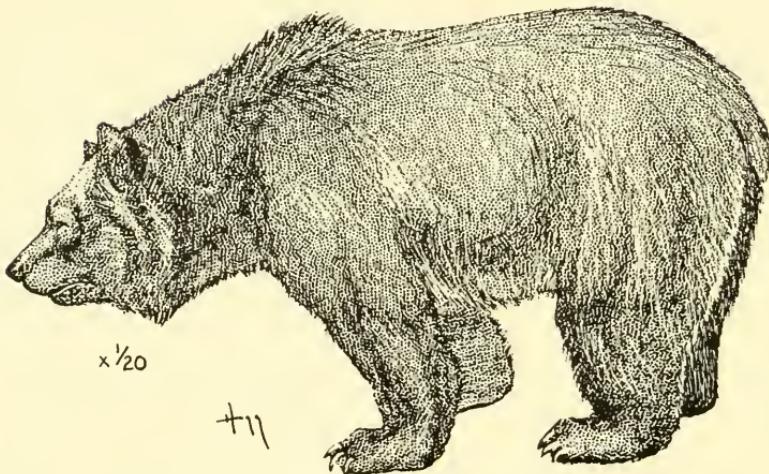


FIG. 56. Three views of skull and left lower jaw of Gray Fox, *Urocyon cinereoargenteus* [subspecies *scottii* Mearns], Colorado River, 2 mi. N Calif.-Nev. Monument, Clark Co., Nevada, ♂, No. 61465 MVZ, $\times \frac{1}{2}$.

FAMILY URSIDAE

Genus *Ursus* Linnaeus

Grizzly Bear

Ursus horribilis Ord

The Grizzly Bear probably ranged over the western two-thirds of Kansas. Indirect evidence and not actual records are responsible for this guess. O. J. Pattie, in 1824, when probably on the dividing ridge between the drainages of the Smoky Hill River and the Republican River, two days travel from Castle Rock, is quoted by Cockrum (Univ. Kansas Publ., Mus. Nat. Hist., 7:238, 1952) as follows: "Here we killed a white bear, which occupied several of us at least an hour. It was constantly in chase of one or another of us, thus withholding us from shooting it, through fear of wounding each other. This was the first I had ever seen. His claws were four inches long and very sharp. He had killed a buffalo bull, eaten part of it, and buried the remainder. When we came upon him, he was watching the spot where he had buried it to keep off the wolves, which literally surrounded him."

All that I have been able to learn about the Grizzly goes to show that he was essentially solitary, afraid of no living creature, and was more diurnal than nocturnal. Despite his evil reputation he did not attack man unless provoked. This bear did not hunt man, and

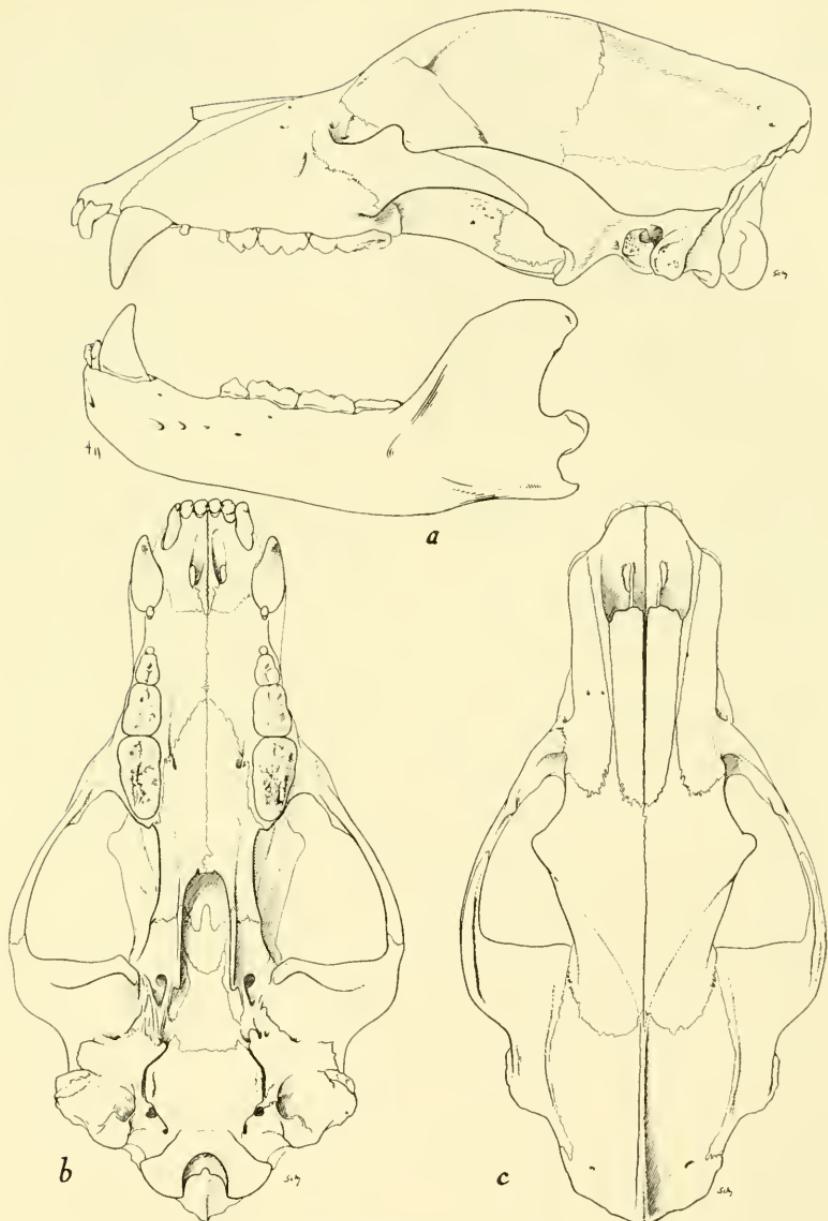


FIG. 57. Skull and left lower jaw [reverse image of right lower jaw], of Grizzly Bear, *Ursus* [species *tularensis* Merriam] from near head of Big Tujunja Canyon, Los Angeles Co., California, ♂, No. 46918 MVZ, $\times \frac{1}{4}$.

a person could avoid trouble by exercising good judgment such as keeping away from fresh caches of food buried by the Grizzly, taking care not to get between a female and her cubs, and yielding the right-of-way when meeting a Grizzly on a trail. Man, however, is like the Grizzly in many respects; for example, Man dislikes to yield the right-of-way on a trail, or anywhere else, to any other animal and when armed with a rifle man seldom does so.

It is understandable, therefore, that many men were injured and some killed by Grizzlies which had been infuriated by bullet wounds, or provoked by some indiscretion of man. Undeniably the Grizzly was dangerous. But man—more exactly man with modern guns—so changed the natural habits of the Grizzly in the United States that he became a nocturnal animal that used his senses to avoid man and that fled whenever the scent of man reached the Grizzly's nose. White Man sought him out in the most relentless fashion and the Grizzly now is extinct in the United States except that there are some in a few remote parts of the Yellowstone National Park and Glacier National Park and perhaps an occasional straggler in adjacent areas. Where Grizzlies and men occur together fatal conflicts are inevitable and I for one hope and pray that if it becomes necessary to choose between man and bear in the Yellowstone National Park we can choose bear and exclude man from these last sanctuaries of the Grizzly, for he was the grandest of all of North America's modern mammals. Only a part, and not the larger part, of the Park would be required as a place "out of bounds" for man.

My own boyhood, all spent in Kansas, was so far removed in time from incidents there that involved Grizzly Bears, if they ever occurred at all in my part of the State, that I had only a detached interest in the conflict between them and men. The first year of two decades that I spent in California, however, made me more conscious of such conflicts, first because I visited territory where the Grizzly was reputed [incorrectly I now think] still to roam and second because, for that general region, the Saturday Evening Post later that same year (p. 153, for December 6, 1924) carried the account of a tragic incident that involved a [Grizzly?] bear and a person who could have been a Kansan.

The account by Mr. Will C. Barnes goes as follows:

"A few years ago the body of an old prospector and trapper known in the region as J____ S____ was found by a ranger in one of the national forests in the high Sierras of California. The body had been terribly mauled and torn by bears and perhaps other wild animals, and all the evidence pointed to a fight to the

death with an old mother bear and two cubs. Nothing was found in the man's effects to lead to the location of his friends, and absolutely nothing of his past or home ties was known in the region. The body was duly and officially viewed by a coroner's jury, which decided he had been killed in a bear fight, and he was buried near where found. Naturally the case got into the local papers, from which it was widely copied. Some weeks later the ranger who found the body received a letter from a woman in a Midwest state, of which the following is an exact copy:

"*Kind and Respected Cir:* I see in the paper that a man J_____ S_____ was atacted and et up by a bare whose cubs he was trying to git when the she bare came up and stopt him by eatin him up in the mountains near your town. What i want to know is did it kill him or was he only partly et up and [is] he from this place and all about the bare. I don't know but what he is a distant husband of mine. My first husband was of that name and I suppose he was killed in the war but the name of the man the bare et being the same i thought it might be him after all and i thought to know if he wasn't killed either in the war or by the bare for I have been married twice since and their ought to be a divorce papers got out by him or me if the bare did not eat him all up. If it is him you will know it by having six toes on the left foot. He also sings base and has a spread eagle tattooed on his front chest and a ankor on his right arm which you will know him if the bare did not eat up these parts of him. If alive don't tell him I am married to J_____ W_____ for he never liked J_____. Mebbe you had better let on as if i am ded but find out all you can about him without him knowing anything what it is for. That is if the bare did not eat him all up. If it did i don't see you can do anything and you needn't take any trouble. My respeks to your family and please ancer back.

"P. S. Was the bare killed. Also was he married again and did he leave any property worth me laying claim to?"

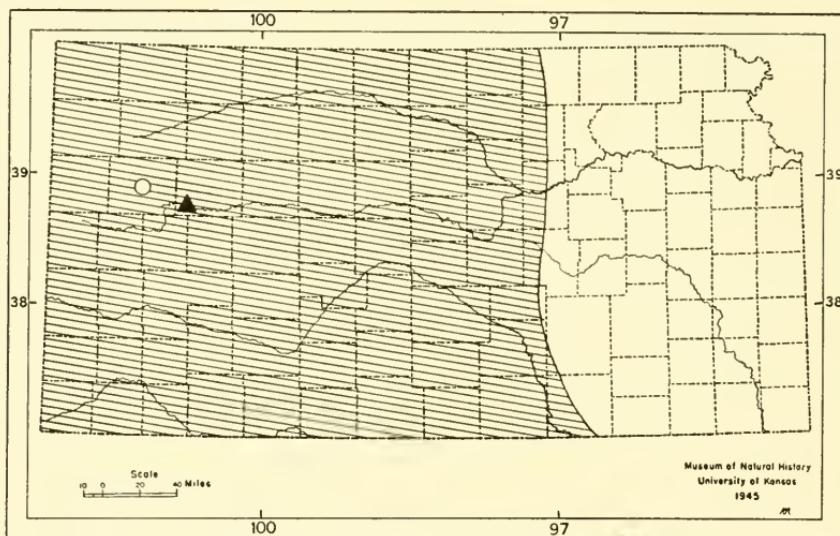
Grizzly Bears leave marks on trees by reaching up as high as they can when standing on the hind legs and sinking an upper and lower canine tooth into the side of a tree and then wrenching away the bark and an underlying slab of wood. It is said that some trees thus marked show also the scratches of the five claws of a forefoot. The purpose of thus marking trees is unknown.

Adult Grizzly Bears are thought not to climb trees—something that Black Bears do. Another difference between the two species is in the winter sleep; the Grizzly Bear in the northern latitudes emerges from his winter den a month to two months earlier than the Black Bear and in southern latitudes does not undertake a prolonged winter sleep at all.

Omnivorous is the term that accurately describes the food habits of the Grizzly. Grass, roots, insects, mice, ground squirrels that the Grizzly digs out, larger animals that it kills on occasion such as bison in the old days, and carrion that it finds all are eaten.

The gestation period is six months and four days. Usually 2, rarely 3 and in two known instances 4, young were born in December and January. In northern areas the young are born while the female is in her sleeping den and they nurse there until she emerges in spring. It is thought that a female gives birth to young only every other year. At birth the young weigh only one and a half pounds and the eyes do not open until the 9th or 10th day of life.

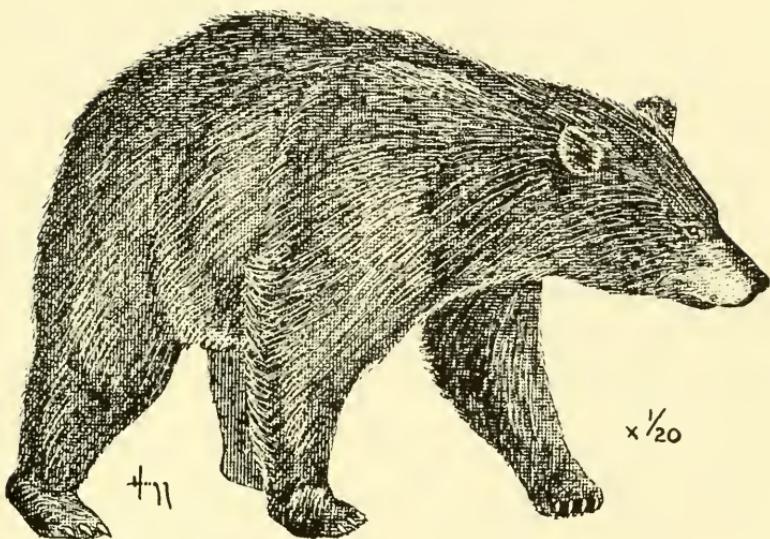
In Wyoming, in spring, a lean male drained of blood weighed 916 pounds; but, 500 for males and 400 for females is heavy there. Many estimates are twice the actual weights on scales. According to many naturalists, there is doubt that any United States Grizzly ever weighed so much as 1500 pounds.



Description.—Males measure: Total length, 1830 (6 ft.)-2237 ($7\frac{1}{2}$ ft.) or more; tail, perhaps 50-75; hind foot, 229 (9 in.)-305 (12 in.); greatest length of skull, up to 470; zygomatic breadth up to 215. Upper parts dark brownish to almost white, scarcely lighter on underparts but hairs on upper parts of some individuals banded with white or pale color imparting the "silver tip" effect. Differences from the Black Bear include: the "hump" in the shoulder region when the animal is walking on all fours; relatively, as well as actually, larger last upper molar tooth (see figures of skulls); and much longer claws on the forefeet, the claw of the second digit being more, instead of less, than $2\frac{1}{2}$ inches long.

Ursus horribilis horribilis is the name that probably applies to the subspecies that occurred in Kansas. The name was proposed by Ord (Guthrie's Geography, 2nd Amer. ed.; 2:291, described on page 299, 1815) with type locality along the Missouri River, a short distance above the mouth of the Poplar River in the northeastern part of what is now the state of Montana.

Black Bear

Ursus americanus Pallas

Black Bears accumulate much fat, at the onset of cold weather find dens—one adult to a den—and sleep until spring. A slight disturbance awakens the bear; it does not hibernate. Kinds of mammals that do hibernate become torpid because of a lowering of the body temperature, the rate of breathing, and the pulse rate.

West of the Mississippi River the color of the Black Bear is almost as often cinnamon as black. In the St. Elias Alps of southeastern Alaska the bluish coat replaces the cinnamon coat and this bluish color-phase is known as the Glacier Bear. On Gribble Island and on the adjacent mainland of British Columbia the animal is white or yellowish white. These black, cinnamon, blue and white phases are merely color varieties such as occur in the litter of a single pair of parents and are not different species.

Smoked hams of the Black Bear are highly regarded in some areas. Because this species harbors the trichina organism many people who have eaten the meat rare have contracted trichinosis with resulting illness and even death.

The food is varied and includes leaves, fruits, roots, acorns, vegetables, insects, fish, flesh of other mammals and carrion.

The Black Bear breeds when three and a half years old. After a gestation period of six and a half months one to five young are

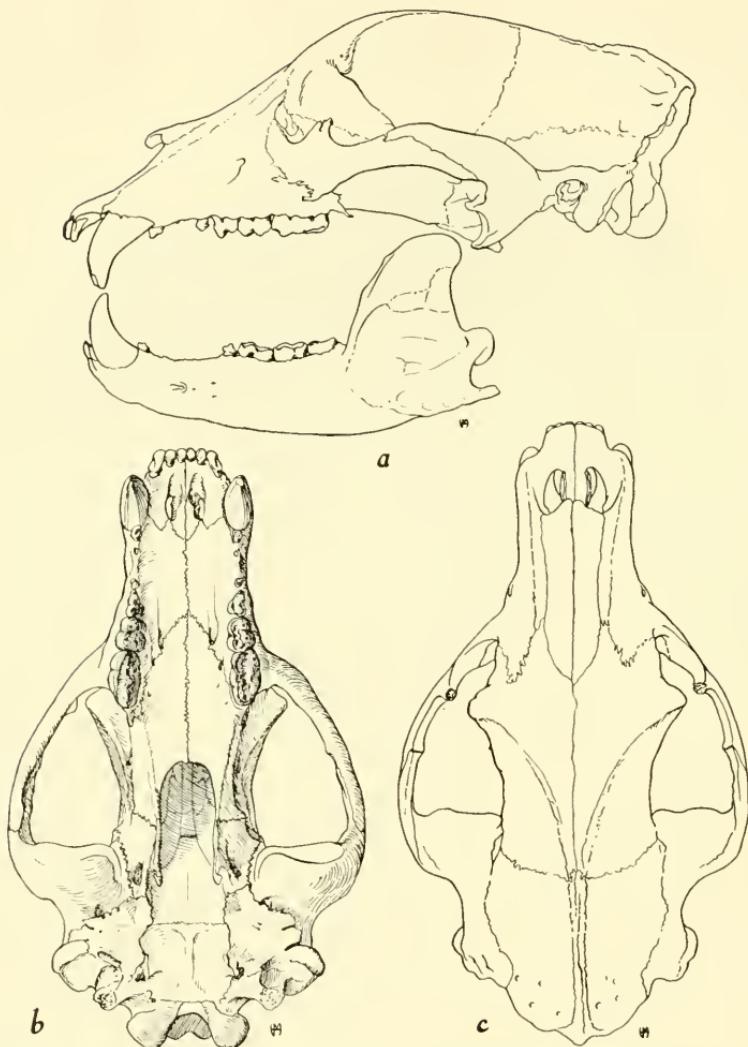
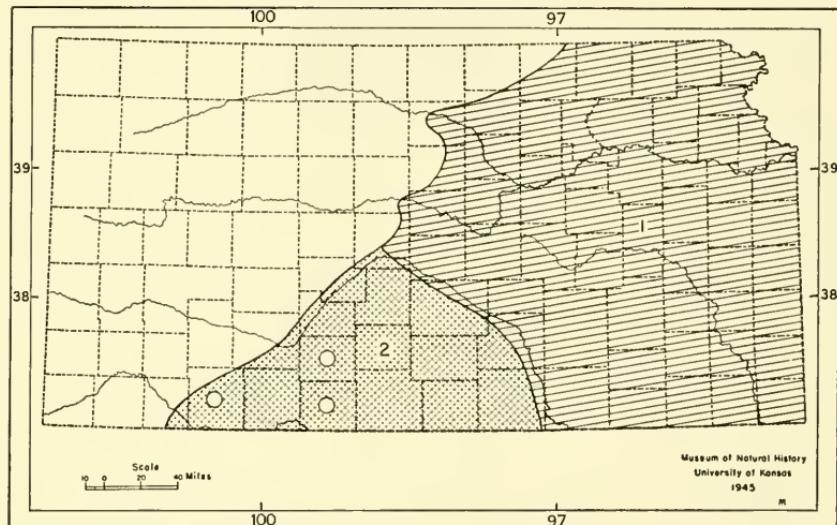


FIG. 58. Skull and left lower jaw of Black Bear, *Ursus americanus* [subspecies *californiensis* J. Miller], 6 mi. N Weldon, Kern Co., California, ♂, No. 16269 MVZ, $\times \frac{1}{4}$.

born in late January; January 21 and 27 are recorded dates. At this time the female is still in her winter den. Two is the usual number of young. At birth the weight is only one-half pound. The eyes open on or about the fortieth day of life.

Perhaps the geographic distribution of the Black Bear in Kansas was state-wide although it may have been absent, or at most of infrequent occurrence, on the flat treeless prairies of the western part of the State. We do know (see Cockrum, *op. cit.*:239) that in

1864 to 1866 J. R. Meade found the animals to be numerous in the broken cañons of Comanche County where the bears had dens in the gypsum caves and reared their young and that Meade and his companions smoked the Black Bears out of the caves and shot the animals. It may be that none survived until so late as 1880. Cockrum (*op. cit.*:240) writes that M. V. B. Knox in 1875 reported some Black Bears still living in timber in central Kansas.



Distribution of *Ursus americanus*.
1. *U. a. amblyceps*. 2. *U. a. americanus*.

Description.—Total length, 1613-1980; tail, 105-127; hind foot, 184-275; weights in excess of 500 lbs. are recorded for males but these are exceptionally large individuals; greatest length of skull, 338; zygomatic breadth, 220 mm. Color black or cinnamon; tail short, a mere anal operculum; lips loose and protrusible; five clawed-digits on each foot; foot soles naked. Females are smaller, perhaps by one third, than males. From the Grizzly Bear the Black Bear differs in smaller size, less pronounced hump in shoulder region when animal is walking on all fours, smaller last upper molar which is also relatively, to the other teeth, smaller, and shorter claws on the forefeet, the claw on the second digit measuring less, instead of more, than 63 mm. (2½ inches long). In the Black Bear the claws of the forefeet are approximately 40 mm. long instead of 75 mm. or longer.

Ursus americanus americanus probably was the subspecies in the eastern part of the State and was named by Pallas (*Spicilegia Zoologica*, Fasc. 14, p. 5, 1780) with type from eastern North America. *Ursus americanus amblyceps* probably was the subspecies that occurred in the southwestern part of Kansas and was named by Baird (*Report U. S. and Mexican Boundary Survey*, 2 (2):29, 1859) with type locality at Fort Webster, lat. 32° 47' N, long. 108° 4' W, on the Gila River, Grant County, New Mexico.

FAMILY PROCYONIDAE

Genus *Procyon* Storr

Raccoon

Procyon lotor (Linnaeus)

Coon hunting in eastern Kansas is a popular nighttime sport. Hounds that trail by scent and that have been trained to follow only Raccoons are used. Ordinarily the Raccoon is "treed." The animal sometimes is dislodged by a person who climbs the tree but more often is located by means of a spotlight and is shot.

In 1952, according to H. J. Stains of the State Biological Survey, who has completed a study of the Raccoon, Kansas had approximately 4,250 Raccoon hunters, owning 12,000 'coon hounds'. Approximately 35,000 persons went on coon hunts. Hunts averaged 3.9 hours long and peak hours were 9, 10, and 11 p.m. Hunters walked 4.2 miles and used 2.9 dogs to obtain 1.2 Raccoons per hunt.

Despite hunting, the Raccoon persists and in the period 1950-1953 increased greatly in response to some favorable, but unknown, features of its environment. Many Raccoons died in the winter of 1952-1953 under circumstances which suggested that there was an epidemic disease among them. The numbers of raccoon pelts sold, according to the biennial reports of the Kansas Forestry, Fish and Game Commission, are suggestive of the increase in numbers in late years. In 1928, 5,789 pelts were sold; in 1929, 24,447; the number gradually decreased year by year to 8,374 in 1940 and then increased year by year to 62,002 in 1949-1950, the last year for which figures are available at this writing. The average price per pelt was only \$1.95 in 1951-52, \$1.21 in 1952-53, and \$1.04 in 1953-54.

Owners of coon dogs have imported and released Raccoons in Kansas from other areas in the probably mistaken belief that releases effectively increase the population. Native Raccoons occur in every Kansas county. Trappers take only 12 per cent of the raccoons harvested annually. Persons who hunt with dogs, or both hunt and trap, take the remainder of the annual catch.

Young are easily tamed and are intelligent. A tendency for mischief ordinarily requires that the pet Raccoon be chained up or disposed of after a time.

Raccoons are omnivorous. In Kansas 55 per cent of the food is vegetable material. In captivity, Raccoons wash their food, if possible, before eating it. In areas where corn is grown it is an important food. In eastern Kansas the Raccoon's most important vertebrate competitors for food, according to Mr. Stains' findings, are the Fox Squirrel, Opossum, Red Fox, Cardinal, Eastern Cottontail, Striped Skunk, Blue Jay, Red-eyed Towhee, Bobwhite, Tufted Titmouse, and Woods Mouse. In western Kansas the chief competitors are Ring-necked Pheasant, Opossum, Striped Skunk, Cottontails, Fox Squirrel, Badger and Deer Mouse.

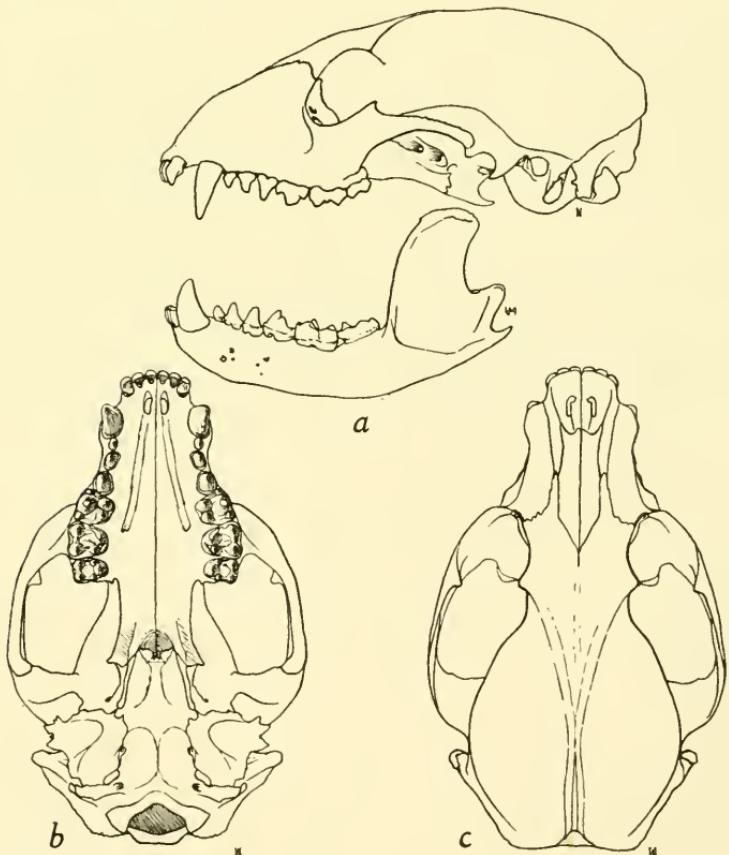
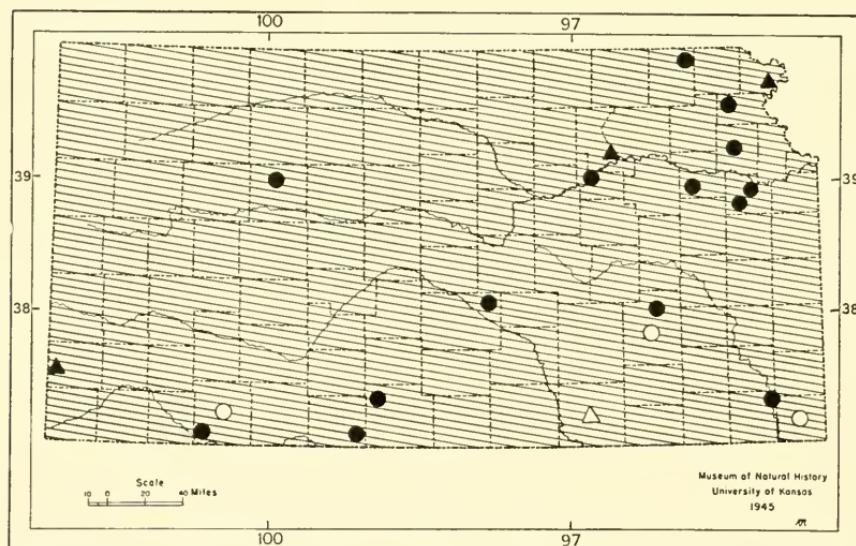


FIG. 59. Skull and left lower jaw of Raccoon, *Procyon lotor* [sub-species *psora* Gray], S end Marlette Lake, Ormsby Co., Nevada, ♀ subadult, No. 70003 MVZ, $\times \frac{1}{2}$.

In winter the Raccoon sleeps when the weather is cold. In the northern part of its geographic range, for example in southern Canada, the Raccoon sleeps for approximately three months but in the southern part of the United States where winters are mild it has no prolonged period of winter sleep. As in the bears, the inactivity seems to be a winter sleep and not true hibernation.

Raccoons are nocturnal. In Kansas, where trees are scarce in many areas, the animals use ground dens more often than tree holes as homes. It is my impression, however, that in timbered areas the Raccoon prefers a hollow, well up in a tree. Several individuals commonly are found in the same hollow. In foraging, however, the animals travel singly, except that the young accompany a parent.



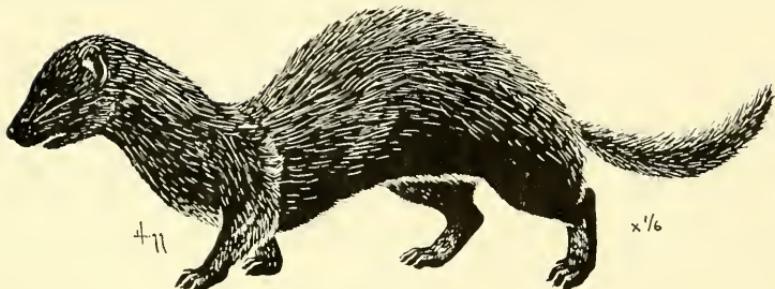
Description.—Total length, 750-850; tail, 233-282; hind foot, 105-126; weight up to 25 lbs.; basilar length of skull, 97-107; zygomatic breadth, 65.2-76.0. Color brownish gray; longer hairs tipped with black on upper parts and with white on underparts; a black patch on each cheek including area around eye, and joining with narrow blackish stripe that runs from nose to dark area on forehead; whitish band above dark area surrounding eye; tail with 6 or 7 dark rings on pale yellowish background. The relatively long forearm ends in a slender hand of lesser diameter than the wrist; the distally tapering forelimb makes the animal difficult to hold in steel traps because the foot can be pulled from between the jaws of all but the strongest traps.

Procyon lotor hirtus is the subspecies in Kansas. It was named by Nelson and Goldman (Jour. Mammalogy, 11:455, November 11, 1930) with type locality at the town of Elk River, Sherburne County, Minnesota.

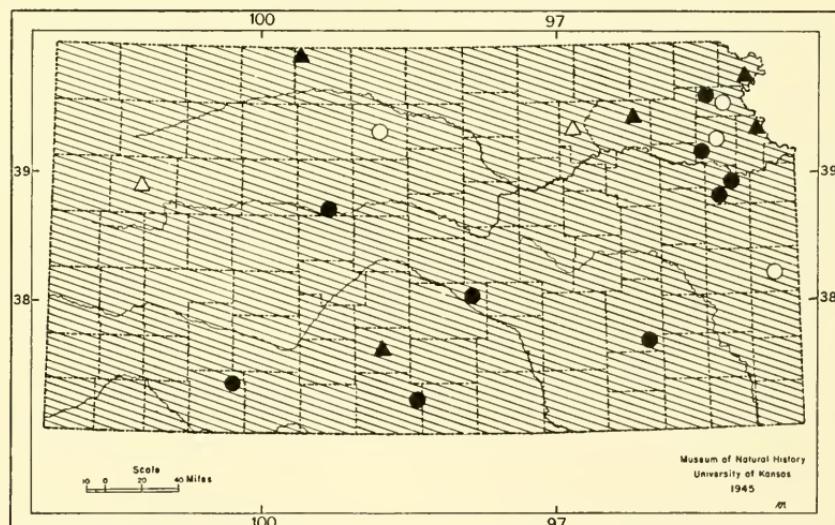
FAMILY MUSTELIDAE

Genus *Mustela* Linnaeus

Mink

Mustela vison Schreber

The Mink lives in and along streams, eats rodents, frogs, fish and turtle eggs, often lives in Muskrat burrows, has one litter per year of 4 to 10 young after a gestation period of 39 to 76 days, yields a pelt that sells for up to \$30 and, therefore, is becoming rare.



Specimens recently received at the University of Kansas Museum of Natural History are from four localities from which the Mink has not previously been reported in the literature. These localities, shown above, are: Big Timber Creek, 4 mi. E Schoenchen (Ellis Co.); 7 mi. NW of Fall River (Greenwood Co.); $\frac{1}{2}$ mi. N Fowler (Meade Co.); and 2 mi. N and 1 mi. E Sharon (Barber Co.).

Description.—External measurements of two males from Douglas County are: Total length, 666, 597; tail, —, 171; hind foot, 72, 70; basilar length of skull, 62.7, 63.4; zygomatic breadth, 39.0, 40.7. Females are a tenth or more smaller in linear measurements than males. Fur dark brown, except for white spots on the throat, chest or belly of some individuals; brown most intense near tip of tail and along the middle of back. Compared with the Long-tailed Weasel the Mink is larger, stockier, relatively shorter-tailed, lacks extensively white underparts and has more nearly flat tympanic bullae.

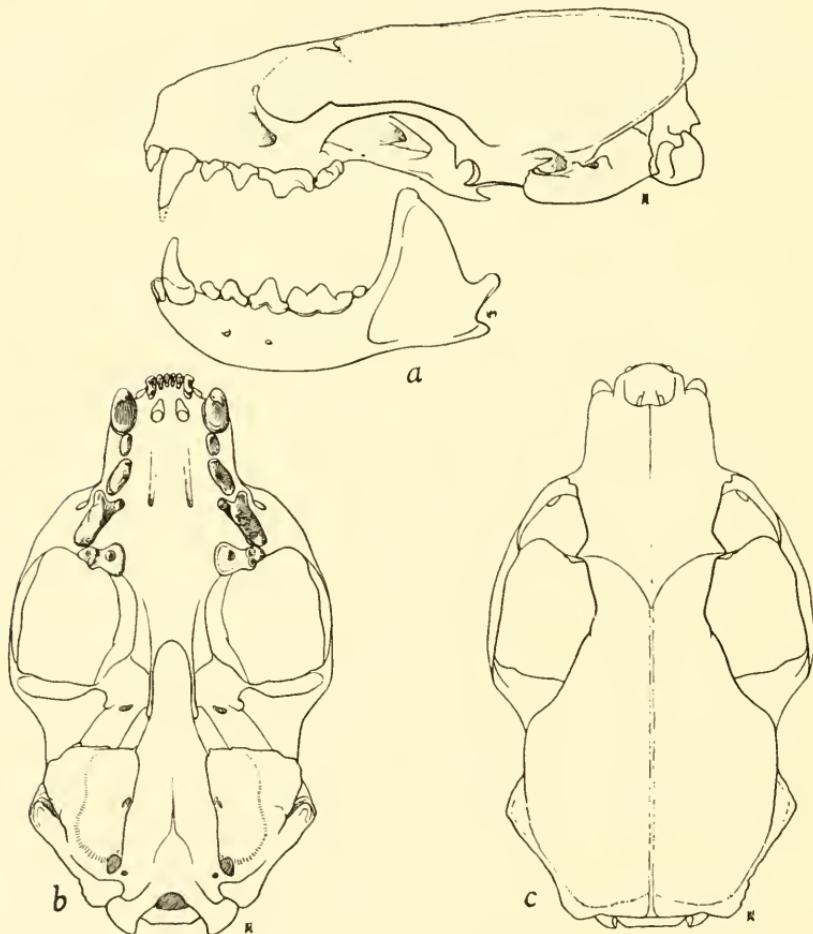
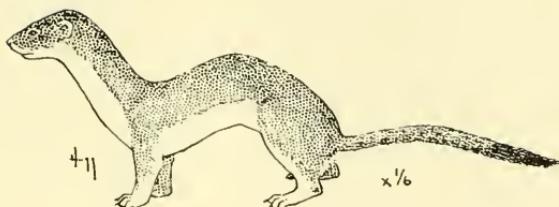


FIG. 60. Skull and left lower jaw of Mink, *Mustela vison* [subspecies *energumenos* (Bangs)], Goose Creek, 5000 ft., Elko Co., Nevada, ♂, No. 74391 MVZ, natural size.

Mustela vison letifera is the subspecies in Kansas and was named by Hollister (Proc. U. S. Nat. Mus., 44:475, April 18, 1913) with the type locality at the town of Elk River in Sherburne County, Minnesota.

Long-tailed Weasel

Mustela frenata Lichtenstein

The Long-tailed Weasel is mainly nocturnal but is sometimes active in the daytime. It lives mostly on the ground but can climb well. Males travel two miles and more in a night although the female goes only half so far. As in the Mink the sense of smell is keen and by this means the weasel can follow its prey. The victim is almost always killed by a bite at the base of the skull. Actually weasels do not suck blood, as frequently is alleged, but when a large vein or artery is severed, for example in the neck of a cottontail, the weasel will lap up the blood. Mice make up most of the food but moles, shrews, ground squirrels, pocket gophers, rabbits, a few birds and rarely insects are eaten. The slenderness of its body permits a weasel to enter any hole, or to pass through any opening, which is big enough to admit its head. Consequently ground squirrels and other rodents can be followed if necessary, to the very ends of their burrows. A knot hole in a chicken coop can be fatal for the young occupants if a weasel chooses to enter. This happened one night on our farm in Johnson County when we lost 38 young chickens. Weasels kill more animals than can be eaten immediately and this has been interpreted, wrongly I think, as a lust for killing. When undisturbed the weasel buries its victims to preserve them. The weasel, probably by instinct, attempts to obtain and store food with much the same object in view that a tree squirrel has when it gathers and stores nuts. The killing of the 38 chickens described above shows that a weasel can be dangerous around a chicken yard. Nevertheless, two poultry raisers that I know of permitted weasels to live under their buildings; the weasels subsisted upon House Mice and Norway Rats without ever molesting the young chicks which sometimes are levied upon by the rats. In a field where small rodents are so abundant as to damage cultivated crops the weasel is the farmer's best friend. The characteristic of remaining in one place as long as food is available there causes the weasel to serve as a real control instead of as a mere

check upon some rodents. One female which took over a burrow of a pocket gopher and reared her five young in it (in White Pine County, Nevada) continued to live in that burrow until all of the pocket gophers within three hundred yards, as well as many other kinds of rodents, had been killed.

Each year a single litter of nine young is born in spring, usually in April, after a gestation period of up to 337 days. Actually the embryos are quiescent for a long time. After they become implanted they grow to full term rapidly, in 27 days. Males breed first in their second year but some females breed in their first year.

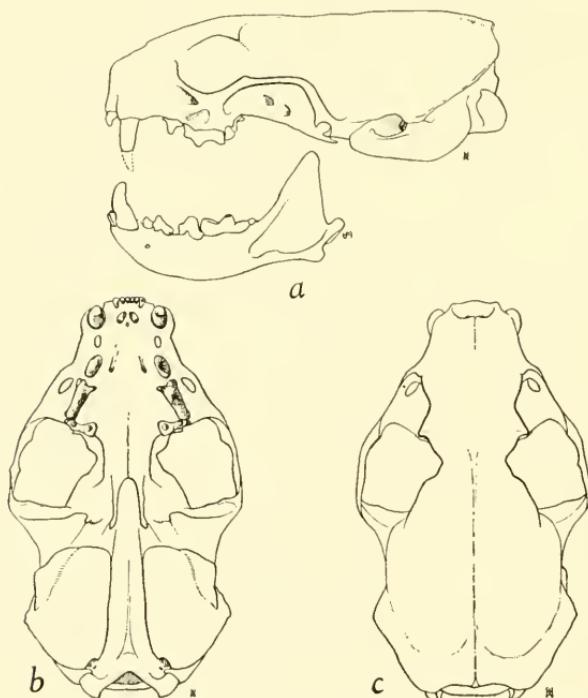
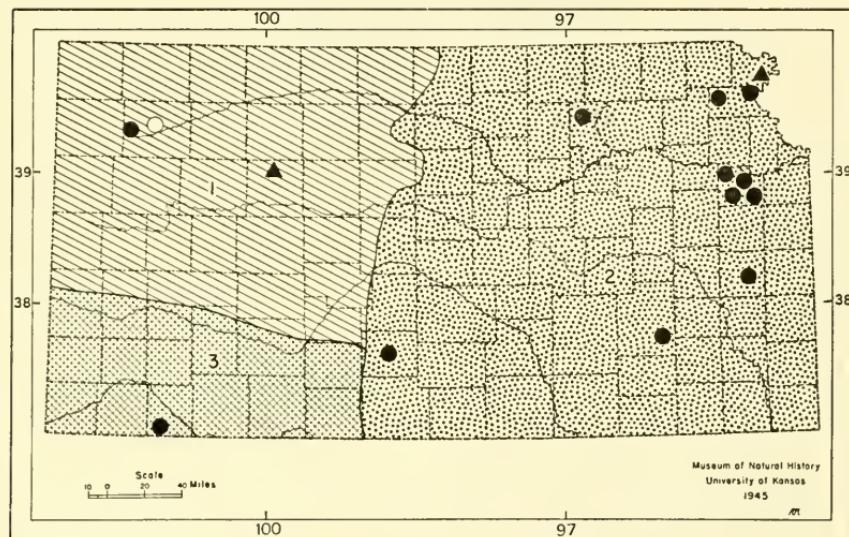


FIG. 61. Skull and left lower jaw of Long-tailed Weasel, *Mustela frenata* [subspecies *nevadensis* Hall], Baker Creek, 8400 ft; White Pine Co., Nevada, ♂, No. 41508 MVZ, natural size.

Approximately twice as many males as females are caught by collectors but there are about equal numbers of the two sexes in nature; the lesser weight of the female (approximately half of the male's weight) permits her to step on the pan of a steel trap without springing it whereas the heavier male does spring the trap and as a consequence is caught. Also, males travel twice as far as females in a 24-hour period.

A captive that I had for many months was several times found in a sleep so deep that he was awakened with difficulty.

The Long-tailed Weasel is the only species of weasel known from Kansas and its nearest relatives are the Mink and Black-footed Ferret. The Least Weasel, only half as long as the Long-tailed Weasel, is to be looked for in north-central Kansas since it has been taken only a few miles north of the State boundary in Nebraska.



Distribution of *Mustela frenata*.

1. *M. f. longicauda*. 2. *M. f. primulina*. 3. *M. f. neomexicana*.

The species occurs in every county in the State, in woods and on open land.

Description.—Total length, male 371-440, female 317-355; tail, 120-147, 95-115; hind foot, 40-47, 34-37; basilar length of skull, 43.8-46.0, 37.6-40.7; zygomatic breadth, 26.2-28.2, 21.1-23.8. These specimens are from eastern Kansas (Douglas County). Specimens from western Kansas average a few per cent larger and the tail is longer relative to the head and body. Upper parts rich brown; underparts white or primuline yellow; tail-tip black; in southwestern Kansas white markings on face; in northern Kansas in winter entire coat (except black tail-tip) white. These white skins are sold on the fur market as ermine and command a higher price than the brown winter skins.

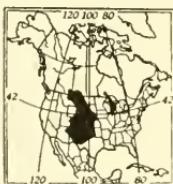
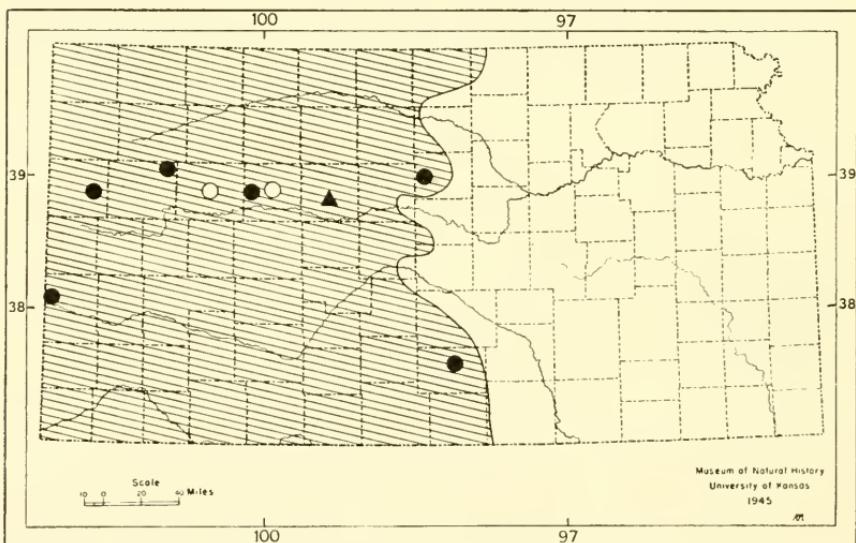
In Kansas there are three subspecies: *Mustela frenata longicauda* Bonaparte (Charlesworth's Magazine Nat. Hist., 2:38, 1838) in northwestern Kansas with type locality at Carlton House, Saskatchewan; *Mustela frenata neomexicana* (Barber and Cockerell, Proc. Acad. Nat. Sci. Philadelphia, p. 188, May 3, 1898) in southwestern Kansas with type locality at Armstrongs Lake, Mesilla Park, Dona Ana County, New Mexico; and *Mustela frenata primulina* Jackson (Proc. Biol. Soc. Washington, 26:123, May 21, 1913) in the eastern half of the State with type locality 5 miles northeast of Avilla, Jasper County, Missouri.

Black-footed Ferret

Mustela nigripes (Audubon and Bachman)



This species ordinarily lives in Prairie Dog towns in burrows made by Prairie Dogs. In Hays, Kansas, in the early days a Black-footed Ferret lived under the wooden sidewalk for several days and killed the rats that had been living there. Now the ferret is rare. It probably will disappear if the Prairie Dog is exterminated.



The Black-footed Ferret originally occurred throughout the western two-thirds of the State; probably its range coincided with that of the Prairie Dog. Now it is rare in Kansas and some zoologists have even thought that it is extinct in the State. A place in Smith County south of Inavale, Nebraska (see Jones and Loomis, Trans. Kansas Acad. Sci., 56:107, March 21(1953); U. S. Highway No. 18 east of Lucas in Lincoln County; and Kingman in Kingman County are the three easternmost record stations of occurrence.

Description.—Two males from Coolidge, Kansas, measure as follows: Total length, 500, 530; length of tail, 125, —; hind foot, 60, 64; ear from notch, 31, 31; basilar length of skull, 62.2, 66.8; zygomatic breadth, 38.8, 43.0. Females average approximately ten per cent less in linear measurements. Pelage pale yellowish buff becoming nearly white on the face, throat, lower parts of body and lower part of tail; top of head and middle of back, brown; black mask across eyes; feet, legs and terminal fourth of tail black to blackish brown.

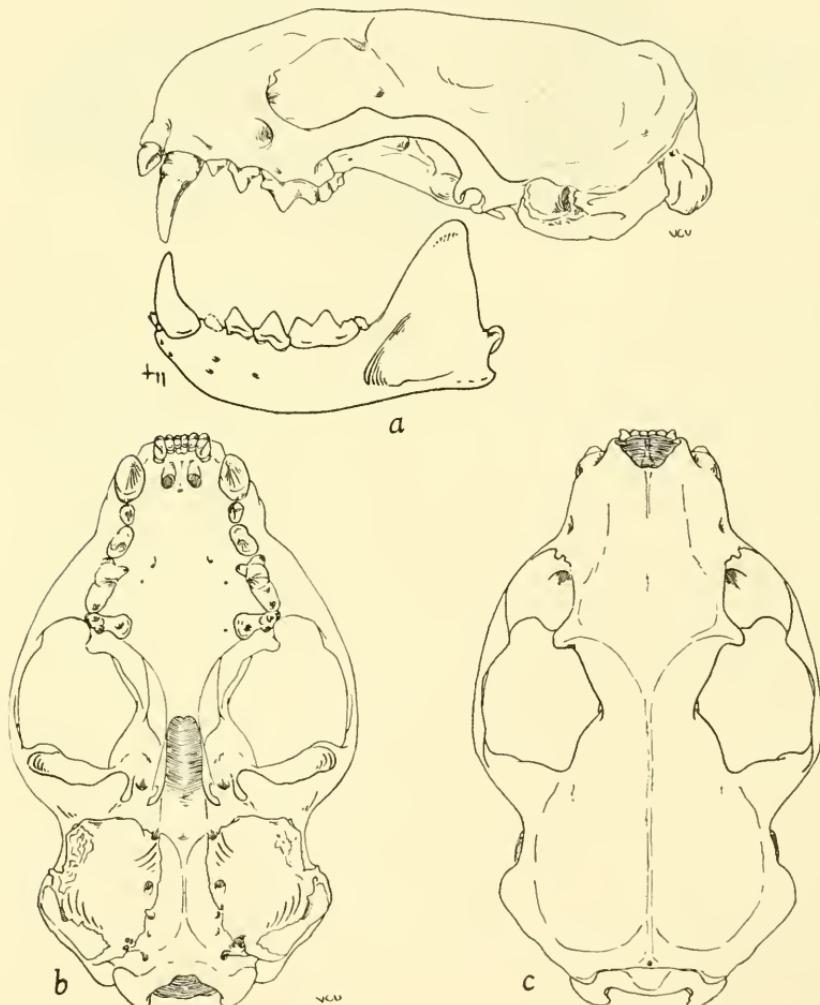
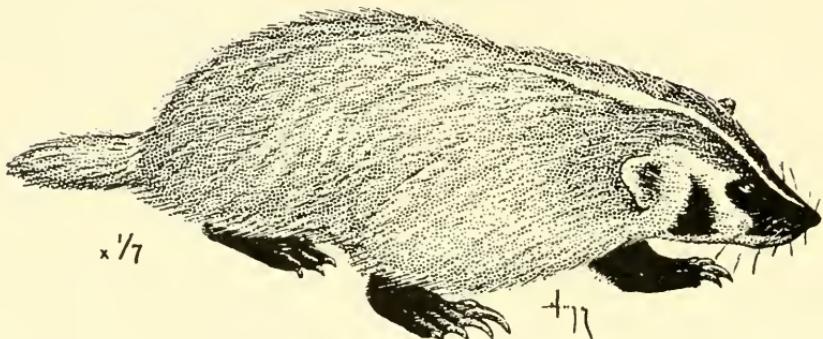


FIG. 62. Skull and left lower jaw of Black-footed Ferret, *Mustela nigripes* (Audubon and Bachman), near Coolidge, Hamilton Co., Kansas, ♂, No. 11077 KU, natural size.

The species was named by Audubon and Bachman (*Quadrupeds of North America*, 2:297, 1851) with type from Fort Laramie, Goshen County, Wyoming. No subspecies have been recognized.

Genus *Taxidea* Waterhouse

Badger

Taxidea taxus (Schreber)

The Badger is the best endowed for digging of all of the carnivores. Not only does it dig a burrow in which to live, but it digs most of its food out of the ground. The food is ground squirrels and other animals of equal or smaller size. Sometimes a Badger will remain in one small area until all of the burrowing rodents there are dug out and eaten. The burrows thus made are wider than high and these dimensions reflect the shape of the animal itself. The unusually powerful forelegs, thick wrists, tremendous tendons and ligaments in the forefeet and huge claws are some of the structural adaptations that fit the Badger for digging. It lives nowhere else than in holes in the ground. In geographic range it is a complement of the Woodchuck and like that animal is a builder of burrows that later are used by many other kinds of animals.

The rapidity with which a Badger can dig is difficult to imagine unless a person has attempted to dig one out. Given a head start of two or three feet no Badger, so far as I know, has been dug out even when several persons joined in the attempt. Even a half grown Badger escaped from my able-bodied companion and myself when we attempted to unearth it by means of shovels.

The skin of a Badger is thick and exceptionally tough. His jaw muscles are strong and his canine teeth are well developed and sharp. Although smaller than the Coyote, the latter is no match for the Badger and it is seldom that a dog can kill one.

The Badger ranges from the plains of Canada south to the southern tip of the Mexican Tableland. Those in the north grow to double or more the size of the southernmost animals. Here we are referring to

weight. Few weights are available for specimens taken in Kansas. I doubt that the largest of ours exceed thirty pounds; that was the largest of more than a hundred that Ray Alcorn handled in Nevada which is in the same latitude as Kansas, although much farther west. There, in Nevada, Badgers hole up for winter sleep in the coldest weather and are active above ground again when the temperature rises to 32° F. or thereabouts. Farther north, in Canada, the animal sleeps the winter through but in parts of Mexico is active all year. In Kansas I suppose the Badger responds to winter temperatures about as he does in western Nevada but this is only a surmise on my part.

The characteristic burrows and tracks are the sign by means of which the presence of Badgers can be detected. The droppings (feces) are buried and in this trait the Badger differs from the other members of its family, the Mustelidae.

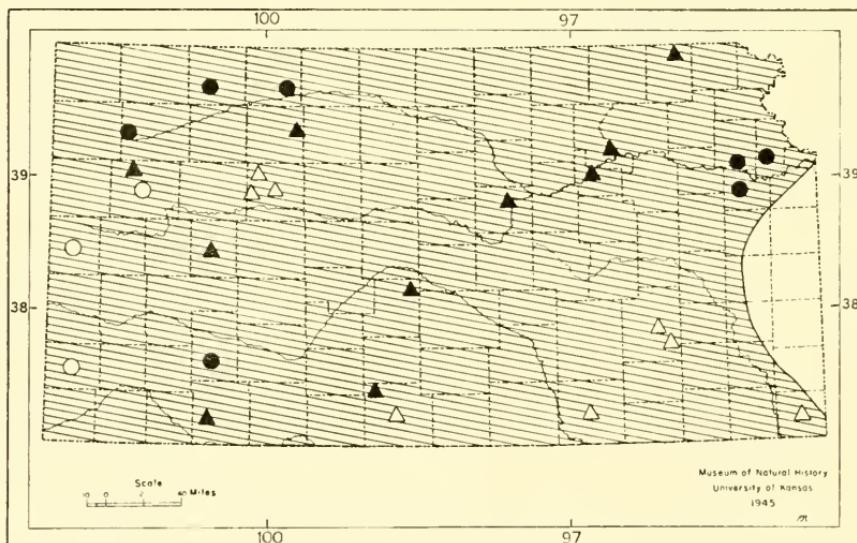
In the northern part of the Badger's range the underfur in winter becomes dense and long but in the southern part of the animal's range there is less underfur and the longer overhair is correspondingly more prominent. Fur Badger and Hair Badger are terms applied to these variations. Badger hair is used in making high quality shaving brushes. The northern animals with the dense underfur command the highest prices on the fur market, and those from the southern part of the range of the species are lowest in price. In the period 1926-1930, fashion created a demand for Badger fur and a well furred pelt of silvery color brought the fur trapper as much as \$75; in those years \$20 was a common price for a good pelt. Such high prices, in effect, placed a bounty on the animal and it was fortunate for the Badger that fashion changed with consequent drop in price of its pelt.

There is one litter of 1-5 young per year. It seems that after fertilization of the ovum there is a delay in implantation of the blastocyst and that the actual development of the embryos occurs mostly in late winter and early spring. At least some females become pregnant when they definitely are less than a year old.

In parts of the west where poisoned baits have been distributed, principally for the purpose of killing Coyotes, many Badgers have been killed by the poison. Because Badgers are burrowing animals, it is believed that many of those that are poisoned retreat below-ground to die out of sight, whereas Coyotes, being essentially cursorial, usually come to their death aboveground. This probably is the reason for a larger proportion of poisoned Coyotes than poisoned

Badgers being found. According to United States Fish and Wildlife Service poisoners, many of the Badgers found dead from poison had only their hindquarters aboveground; before death overtook them, the burrowing instincts of the mortally ill animals operated to a degree that resulted in their partly burying themselves.

In the days of the open range, cowboys complained that the holes made by Badgers were hazards to running horses and to their riders. Otherwise there is little or no basis for complaint concerning the animal and from man's point of view the Badger is beneficial because of the field rodents that he destroys, thus preventing an overpopulation of these rodents.



The Badger occurs over all of Kansas except the eastern tier of counties in the central part of the State. Prior to 1940 the Badger did not occur in much, if any, of eastern Kansas but by 1950 the animal had extended its range into northeastern Kansas as far south as Douglas County. In the autumn of 1952 a reliable report was received of one killed on the highway six miles due south of Lawrence.

Description.—Measurements of a male from $\frac{1}{2}$ mi. W Perry and a female from 4 mi. SE McLouth, both places in eastern Kansas, measure, respectively as follows: Total length, 773, 719; tail, 135, 111; hind foot, 104, 102; ear from notch, 52, 49. The male weighed 21 lbs. and 6 oz. Basilar length of skull, 100.4-111.8; zygomatic breadth, 71.5-82.3. Upper parts mostly silvery gray; underparts paler, often white along mid-line; white stripe beginning at nose extends over head and to between shoulders or farther on back; crown, and muzzle above, brown; feet, bar on each cheek, and back side of each ear black.

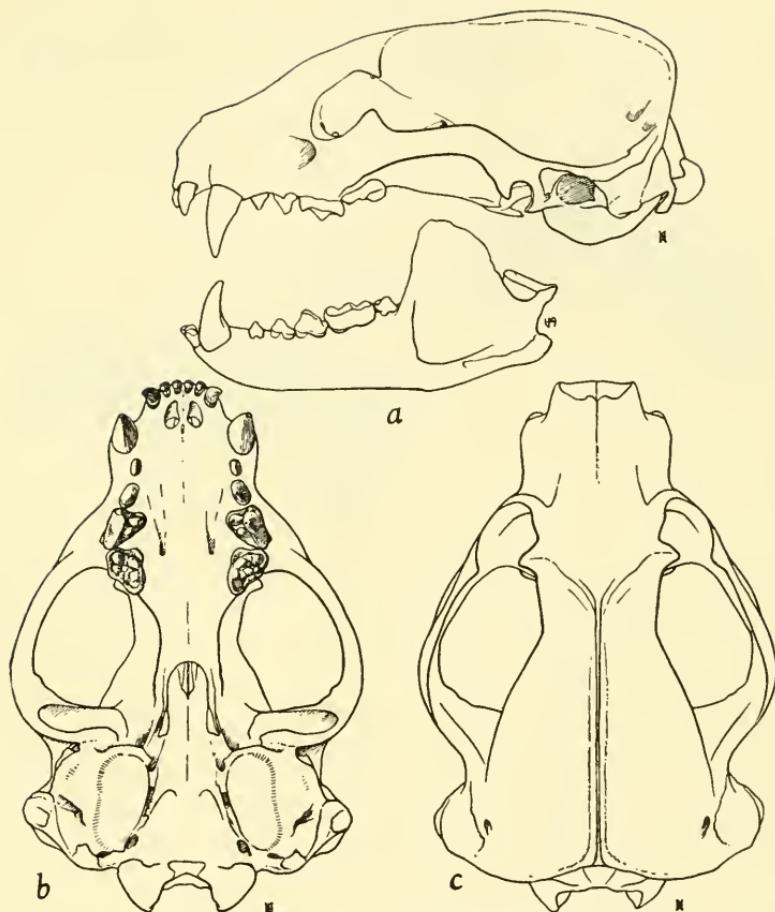


FIG. 63. Skull and left lower jaw of Badger, *Taxidea taxus taxus* (Schreber), Spring Valley, White Pine Co., Nevada, ♂, No. 41467 MVZ, $\times \frac{1}{2}$.

Cockrum (Mammals of Kansas, Univ. Kansas Publ., Mus. Nat. Hist., 7:253, August 25, 1952) assigned specimens from all parts of Kansas to the subspecies *Taxidea taxus taxus* named by Schreber (Säugetiere, 3:520, 1778), the type specimen of which was said to have come from Hudson Bay although it almost certainly came from a considerable distance southwest thereof. In recent years, however, Miss Viola S. Schantz has proposed at least three additional subspecific names that she has applied to specimens from Kansas. These names are as follows: *Taxidea taxus montana* Schantz (Jour. Mamm., 31:90, February 21, 1950) with type locality 35 mi. S of Dillon, Beaverhead County, Montana, and applied to specimens from Greeley and Thomas counties, Kansas; *Taxidea taxus merriami* Schantz (Jour. Washington Acad. Sci., 40:92, March 21, 1950) with type locality at Banner, Trego County, Kansas, and applied to nine specimens from Trego, Lane, Harper, Meade, Stafford, and Logan counties; *Taxidea taxus kansensis* Schantz (Jour. Mamm., 31:346, August 21, 1950) with type locality 4 mi. SE McLouth, Leavenworth Co., Kansas, and applied to eight specimens from Nemaha, Douglas, Riley, Leavenworth, Greenwood and Jefferson Cos.

Genus *Mephitis* Geoffroy and Cuvier
Striped Skunk

Mephitis mephitis (Schreber)



This animal is best known for its odor produced by the liquid in two musk glands, the attached muscles of which provide for expelling the musk or scent at will from either one or both of the glands. These glands are situated at the base of the tail, one on each side of the anus. A short duct leads from the muscular-walled gland to the edge of the anus and ends in a small papilla. The musk is a golden yellow, slightly phosphorescent, highly volatile fluid, one important ingredient of which is the sulphide known as mercaptan. The fluid can be directed with great accuracy for a distance of 10 feet or more. It can be discharged directly to the rear, but usually is shot sideways or even forward toward where the skunk is looking; it has the ability to shoot the musk forward by bending the body in an arc so that a papilla of one of the musk glands points to the place where the animal's eyes are directed.

The musk is used strictly for defense and in no sense for offense. Before releasing the musk, the skunk warns his tormentor to keep his distance. The skunk does this by raising its tail, by hissing in a wheezy fashion, and by stamping the forefeet on the ground. If given the chance, the skunk will go about its business without releasing the musk. No skunk discharged it at me when I stood still or retreated; only when I made a quick movement near the animal, or when I had injured one, did I become the recipient of his discharge. If a person moves deliberately he may do almost anything with a wild skunk in a place from which it cannot escape, short of squeezing it, without causing a discharge of the musk.

In order to illustrate some of the difficulties apt to be encountered by a person who changes from a deliberate to a hasty method of approach when dealing with a skunk, and to illustrate the effectiveness of the musk in disabling an aggressor, an experience of mine, when I was approximately 12 years old, is recorded below.

Early one morning in the autumn of 1914 or 1915, two miles south of Le Loup, Franklin County, Kansas, I found a skunk in a steel trap that had been placed the day before just underwater at the edge of a branch. The trap was set in the hope of catching a Muskrat for a neighbor. He wanted to apply the fresh skin flesh-side-in between his shoulder blades. He thought this might cure him of his asthma. Because the pelt of a skunk was unprime so early in the autumn, I decided to take the animal alive and keep it until midwinter. Slowly picking up the pole to which the trap was secured, I lifted the trap and skunk up over the four-foot bank onto level ground. Taking several minutes to the task, by slow movement I gained a position directly over the animal, with my left hand near his head and my right hand near his tail. Standing thus for a time, waiting for him to lower his tail that was raised aloft as a warning, my growing impatience caused me to decide on a quick movement. My decision was to grasp the back of the skunk's neck in my left hand while my right hand grasped his tail and brought it down between his hind legs. When securely grasped in this manner he could easily be freed from the trap without throwing musk on me. With this plan of action well in mind I made my first quick move; but the skunk was quicker. All in an instant he turned on his back, sank his teeth into my left hand between the thumb and forefinger, and discharged his musk full in my face, completely blinding me. Using my right hand to choke the little animal and to work blindly at his jaws, it required the better part of a minute to break his hold. Once free, I reeled backward and toppled over the bank into the water of the creek. In a way this was fortunate, for I could, and did, wash my eyes and face. The pain in my eyes was intense, but in a few minutes, certainly in less than 10, I regained my sight, and the severe pain gradually disappeared, to be gone after four hours. Noticeable congestion of the mucous membrane in my nose cleared up even sooner, as I now remember it. The burning on my cheeks and a resultant rash lasted all day.

After recovering my sight I found a partly decayed willow limb, with it stunned the skunk by a blow on the head, released the ani-

mal from the trap and reset it, carried the skunk home and confined him in one of several barrels that originally had been used for storage of rock salt for livestock. These empty barrels made good cages when turned on their sides, faced with $\frac{1}{2}$ -inch wire-mesh on the open end, and partly filled with hay. A $\frac{1}{2}$ -pint cup filled with warm milk night and morning and the hind quarters or similar-sized part of a cottontail rabbit once a day was the diet for each of my half dozen or so Striped Skunks. (All except the one "broad stripe" were captured later in the year.) This fare seemed adequate for they thrived and when pelted in early January they had glossy, thick-furred pelts. Because of individual traits and temperaments that made me fond of these animals I found it difficult, in completing the commercial undertaking, to bring myself to kill them. The individual which had temporarily blinded me and the bite of which resulted in an infection that required a month or more to heal was a "broad stripe," commercially the least valuable of any one of my captives. After three months in captivity he escaped a night or two before I pelted the others!

Only one of my animals ever expelled musk while he was in captivity and that was when a dog sought to tear the wire from a cage. In captivity the skunks soon became tame and made good pets. Individual temperaments varied greatly. Skunks can be rendered incapable of emitting scent by a relatively simple surgical operation. As described by Ernest Thompson Seton on page 333 of volume 2 of his "Lives of Game Animals" there are four different ways of disarming: a. by snipping off the nipples inside the rectum so that adhesive healing follows, permanently sealing the fluid in; b. by cutting the ducts deep in near the sacs; c. by pulling the sac out through the orifice that the nipple covers and cutting off the sac; d. by totally cutting out both glands from the outside. There are grave objections to the first three. The operation is most successfully and easily performed when the skunks are kittens but can be performed on adults. A general anesthetic is not recommended.

The odor of the skunk's musk is generally regarded as highly unpleasant. In concentrated form it seems to be unpleasant to all animals, but in dilute form, to some persons, myself included, is rather the opposite. I have wondered if some persons who complained of the odor in dilute form may not have done so because of a prejudice gained early in life by noting the reactions of their elders, when in truth the odor in dilute form might just as well have been regarded as delightfully fragrant.

Striped Skunks are essentially nocturnal. Ordinarily they leave their burrows at late dusk, and it is a common sight to see a female followed by her young in single file on their way to a foraging place. When the female is rearing her brood the male lives alone. Skunks can dig burrows but I think ordinarily enlarge the burrow of some smaller animal or take over the unused burrow of Wood-chuck or Badger. In summer and in early autumn many skunks occupy burrows that they desert at the onset of cold weather. With the coming of cold weather they resort to deeper dens and more of them—up to fourteen in one instance—live together in one burrow. In cold weather they rarely venture out but when a thaw occurs after several days or weeks of really cold weather the animals are out actively foraging. For the period of winter sleep much fat is accumulated in autumn; in spring the animals are lean. In autumn some individuals drag dry grass and leaves in the burrows to make nests.

Almost 100 per cent of the food consists of insects in seasons when these are obtainable; in late autumn and in winter mice are the principal food. The cone-shaped pits dug by skunks in quest of insects or their larvae are well known to observant naturalists. I have noted nests of bumble bees dug out by Striped Skunks; they may have been seeking the bees or the honey or both.

Striped Skunk pelts furnish a large percentage of the furs sold from Kansas. According to the amount of white on the pelt, fur buyers classify pelts from Kansas as: (1) black, although there usually is a patch of white on the top and back of the head and of course a narrow line of white down the forehead; (2) short stripe, denoting individuals in which the two white stripes extend only part way to the base of the tail; (3) narrow stripe, in which each stripe is less than an inch in width but extending all the way to the base of the tail or onto the tail; and (4) broad stripe, in which the pattern is the same as in the narrow stripe although the stripes are wider. In Franklin County I found three patterns in one litter and I suppose that all four patterns occur in some litters.

Whereas most mammals are light colored below and dark colored above, the coloration of the skunks is exactly the reverse. This color pattern may be concealing and may therefore protect the skunk from kinds of animals that would do him harm. The Great Horned Owl is one enemy that kills Striped Skunks. Possibly the black and white coloration of the Striped Skunks is obliterative and of value to the skunks by enabling them the more successfully to stalk small ani-

mals used as food. The color probably has warning significance, and is of survival value because it protects the skunks from would-be enemies, the enemies having learned that the black and white pattern is associated with the to-be-feared musk. Possibly the color pattern is useful in two, or all three, of the ways mentioned.

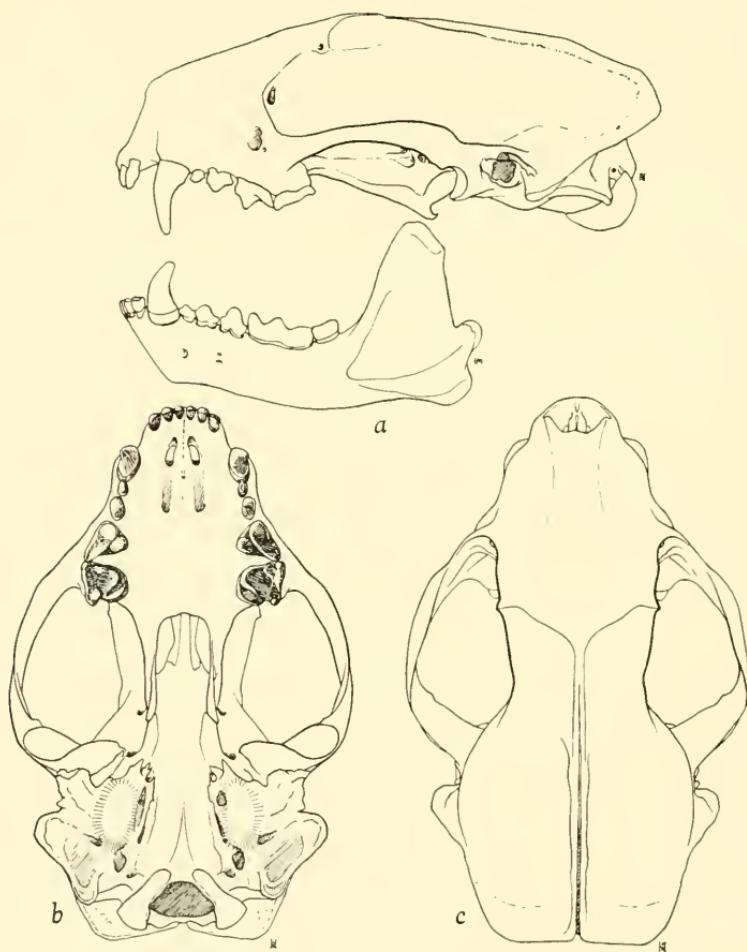
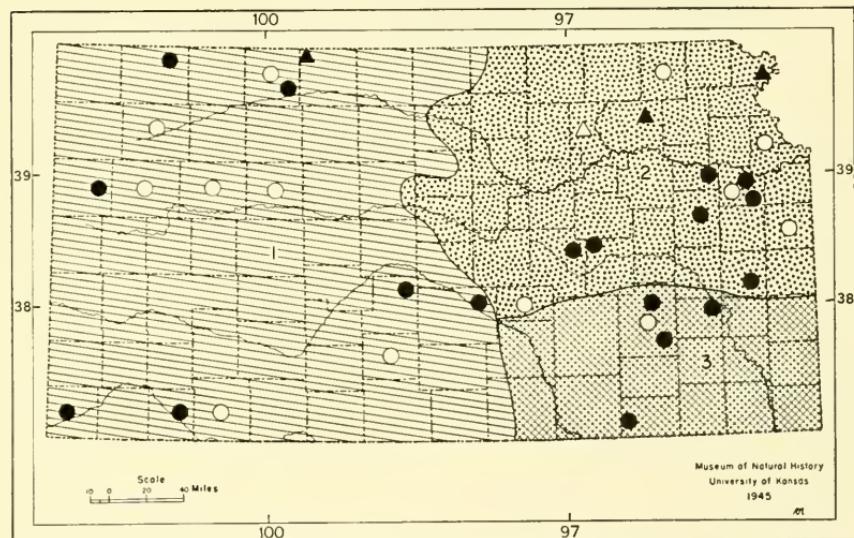


FIG. 64. Skull and left lower jaw of Striped Skunk, *Mephitis mephitis* [subspecies *major* (Howell)], 1 mi. SE Lovelock, 4000 ft., Pershing Co., Nevada, ♂, No. 90562 MVZ, $\times \frac{4}{5}$.

In 1949 at my home on the outskirts of Lawrence, Kansas, I heard, on February 23, sounds that can best be described as something between a growl and a snarl. The sounds reminded me of those made by Norway Rats when they were fighting but were

slightly different. The next year on the same date the same sounds were heard. My son, Hubert, and I traced the sounds and the beam of our flashlight revealed two male Striped Skunks locked in combat at the base of a rock ledge in which there were three dens within a radius of 20 feet. In the last week of February in 1951, and again in 1952, I heard the same sounds. The fighting, I suppose was to gain some advantage in breeding activity.

The gestation period is 63 days. Two to 16 embryos have been found in one female. Six, seven and eight are common numbers of young in a litter. The eyes open on the 17th to 20th day of life.



Distribution of *Mephitis mephitis*.

1. *M. m. varians*.
2. *M. m. avia*.
3. *M. m. mesomelas*.



Description.—Measurements of four males and four females from Douglas County are as follows: Total length, ♂ 633 (597-736), ♀ 612 (560-635); tail, 237 (191-270), 240 (229-254); hind foot, 78 (70-89), 66 (55-79); basilar length of skull, 68 (65.6-70.8), 62 (60.8-62.3); zygomatic breadth, 47.9 (46.1-49.2), 43.3 (42.0-44.3); the cranial measurements are of only three specimens of each sex. Color black except for white markings on head, back and tail (see above for description of white markings).

Three subspecies occur in Kansas. *Mephitis mephitis varians* occurs in the western half of the State and was named by Gray (Charlesworth's Mag. Nat. Hist., 1:581, 1837) with the type from Texas. *Mephitis mephitis avia* occurs in the northeastern quarter of the State and was named by Bangs (Proc. Biol. Soc. Washington, 12:32, March 24, 1898) with type locality at San Jose, Mason County, Illinois. *Mephitis mephitis mesomelas*, in southeastern Kansas, was named by Lichtenstein (Darstellung neuer oder wenig bekannter Säugethiere, pl. 45, fig. 2, 1832) with the type from Louisiana.

Genus *Spilogale* Gray
Spotted Skunk
Spilogale putorius (Linnaeus)



Anatomical study of this species and its relatives reveals that the muscles of the Spotted Skunk are arranged in such a way that it can more nearly handle itself in the manner of the agile Mink or Long-tailed Weasel—something that the Striped Skunk is not equipped to do. The Spotted Skunk can climb trees—something that the Striped Skunk seems unable to do. In Franklin County early one cloudy morning I found a Spotted Skunk seven feet up in an Osage orange tree in a hedgerow. Why it was there I do not know; the Spotted Skunk is characteristically nocturnal and rarely is seen abroad in the daytime.

Civet Cat is a vernacular name widely used in Kansas for this animal and the pelt is sold under that name. I can remember two periods when the fur of the Civet Cat was fashionable. In those years a good pelt sold for as much as a dollar and a half; in most years, however, fifty cents has been a high price for a pelt.

Spotted Skunks more often enter inhabited houses than Striped Skunks do and are said to be efficient mousers. Spotted Skunks also kill, or drive out, Norway Rats. When the skunk is not wanted in a building and has to be caught to be removed it is useful to remember that he will enter a length of stove pipe, or drain pipe, that is laid along the wall. Once inside such a pipe it is a simple matter to close both ends and carry the skunk to a convenient place, thus avoiding the odoriferous incidents that usually ensue if it is captured or eliminated by any one of several other means.

Shelter of some sort is essential to the Spotted Skunk. When our roads had culverts of wooden planking supported by stone abutments these culverts were likely den sites; Spotted Skunks found concealment in burrows that lead behind the abutments.

The hand-stand posture sometimes is assumed by the Spotted Skunk. Balancing the body in a vertical position on the forelegs, with tail drooping forward and downward, the animal is in a position to direct its musk in almost any desired direction. The scent of the Spotted Skunk is keener and has more of a bite to it than does the more mellow scent of the Striped Skunk.

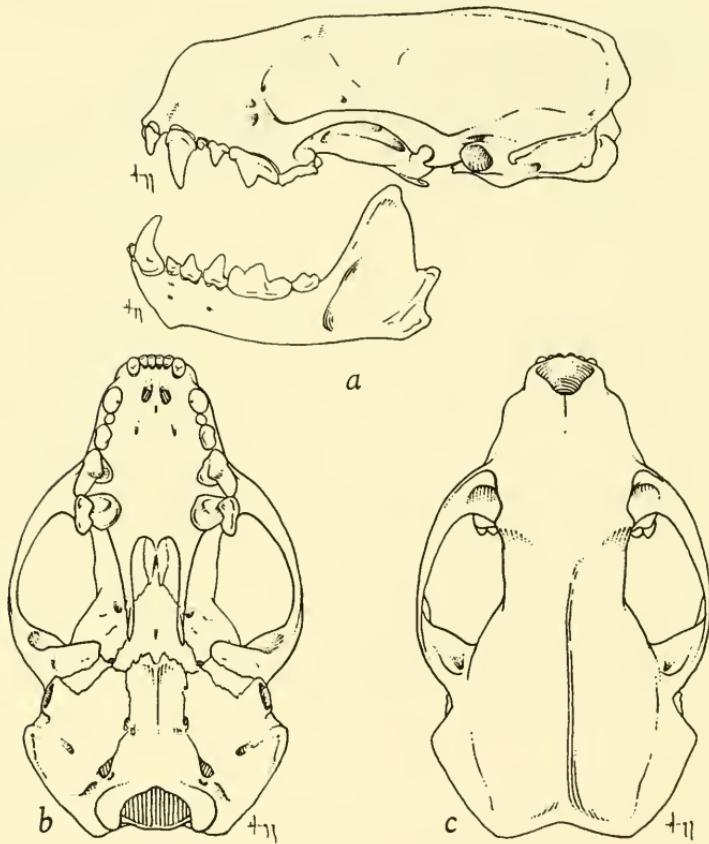
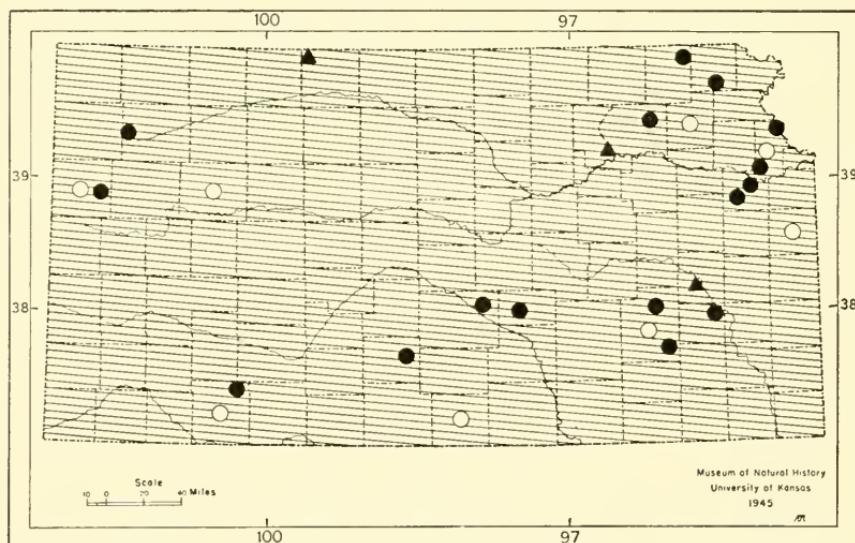


FIG. 65. Skull and left lower jaw of Spotted Skunk, *Spilogale putorius interrupta* (Rafinesque), 1½ mi. N Fowler, Meade Co., Kansas, ♂, No. 14237 KU, natural size.

Wilfred D. Crabb (Jour. Mammalogy, 22:349-364, 1941, and 25:213-221, 1944) in southwestern Iowa studied this species intensively and is responsible for most of the exact information that we have on record concerning its food and growth of the young. His study of 834 scats (fecal droppings) showed the animal to be omnivorous. In summer and autumn most of the food was insects whereas in winter and spring mice constituted the principal food.

Hydrophobia Skunk is another name sometimes applied to this mammal in the southwestern United States. It is to be supposed that this skunk, like any other mammal, contracts hydrophobia. Like any other carnivore in an advanced stage of this disease, the Spotted Skunk probably attempts to bite other animals. In the past this skunk probably has transmitted rabies to persons in the southwestern United States. Certainly it has bitten persons who were sleeping in the open. Anyone bitten by a wild carnivore is using good sense to obtain the animal and have it examined for rabies.

This species has one litter per year of 2-7 young. The weight at birth is approximately 10 grams or one forty-eighth as much as an adult female and one one-hundredth as much as an adult male. The eyes open on or about the thirty-first day. Adult size is attained after three and a half to four months.



Description.—Measurements of three males and two females from Douglas County are as follows: Total length, ♂ 445, 567, 553, ♀ 426, 431; tail, 197, 235, 191, 140, 165; hind foot, 70, 53, 53, 47, 45; weight, 2 lbs. 2 oz. for average male and 1 lb. 1 oz. for adult female; basilar length of skull, 51.4-55.2, 46.2, 47.6; zygomatic breadth, 35.1-36.7, 30.8, 31.6. Black with spot of white on forehead, a white spot on each cheek just before the ear, four lines of spots beginning at head and reaching a little beyond middle of body; two lines of four spots (eight spots in all) across hinder back and sides, a white spot at the rear at each side of tail, and a white spot on base of tail at each side.

Spilogale putorius interrupta is the subspecies in Kansas. It was named by Rafinesque (Annals of Nature, 1:3, 1820) from the upper Missouri River.

Genus *Lutra* Brisson

River Otter

Lutra canadensis (Schreber)

When White Man first came to Kansas the River Otter was found along all of the larger streams and probably occurred at times also along all of the permanent smaller streams. The last otter, taken in Kansas, of which we have record, was captured near Manhattan in September 1904.

Although thought to be primarily nocturnal, the River Otter is active for much of the daytime. My own experience with them is limited; one that I set a trap for on Goose Creek in Elko County, Nevada, two miles west of the Utah boundary, left his tracks where he had bypassed my trap in the night. One that I saw at Turrialba, Costa Rica, was swimming at mid-day in the Río Reventozón. Another that George Young and I saw near mid-day in Lake Gatun, Panamá, was only a few feet from shore and may have been driven into the water by our approach. When rivers and lakes freeze over solidly for long periods of time, otters leave little or no sign above ground; the available evidence is that the otters then confine themselves to their underground dens that have openings into the water several feet below the water line and of course swim below the ice in the waters into which the burrows open.

The speed and dexterity with which the River Otter handles himself in the water is truly marvelous. Such speedy fish as trout and salmon can be overtaken and caught by the otter. At times otters travel several miles overland from one body of water to another, humping the back at each bound of their heavy gallop if we may judge from the gait of captives that I have watched in the National Zoological Park in Washington, D. C.

One of the characteristic signs of otters on the banks of streams, at least in the latitude of Kansas, was the slides. These are said to have been anywhere from 20 to 40 feet long and were on steep banks rising out of deep water. These slides were used for play and two or more otters, instead of only one alone, seemed to use such slides. In my early youth at Imes, Kansas, I knew a man, Grant Richie, who had caught a pair of River Otters in the Marais des Cygnes River a couple of miles below Imes, Franklin County, in 1898, by setting his trap at the foot of just such a slide.

This evidence of social activity and exercise for fun fits well with the behavior of tame River Otters in captivity; their owners credit

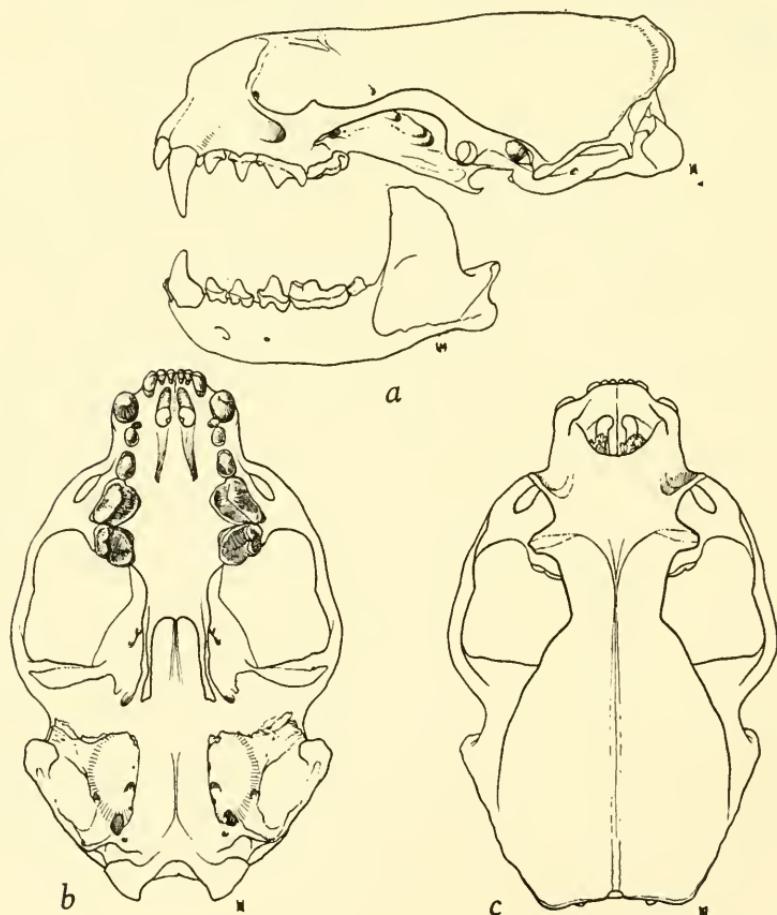


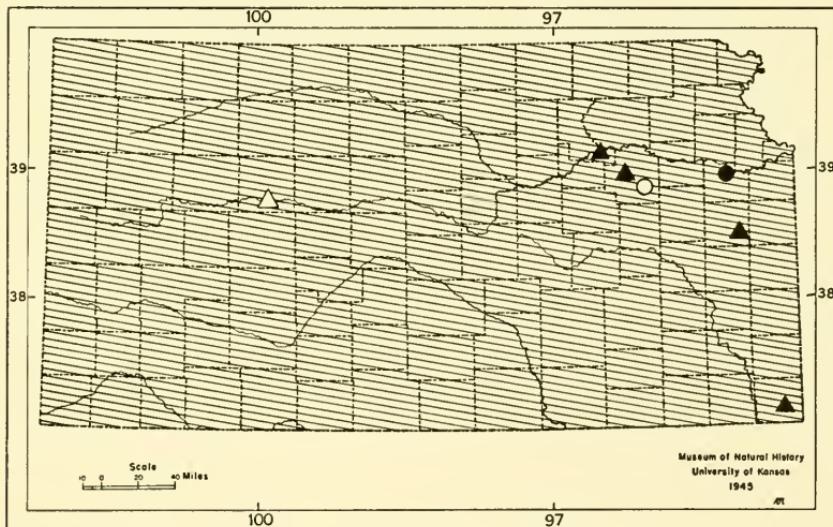
FIG. 66. Skull and left lower jaw of River Otter, *Lutra canadensis* [subspecies *sonora* Rhoads], Colorado River, 8 mi. upriver from Needles, San Bernardino Co., California, ♂, No. 61451 MVZ, $\times \frac{1}{2}$.

such otters with great perspicacity and playfulness. All reports are that the River Otter makes a friendly, intelligent pet—one that is courageous as well. There is an account of a fight in nature between a River Otter and a Bobcat; the Bobcat was killed!

The short glossy fur of the River Otter has commanded a high price for many years—so high a price that trappers took the very last individuals in our State. In the years between 1928 and 1940, \$30 was a price commonly received by the trapper in the western part of the United States for a prime pelt of a River Otter.

River Otters eat fish, but crayfish, frogs and other aquatic animals make up a larger share of the food than does fish.

Two to three young are born in the spring. They are blind at birth. The male seems to join with the female in providing food and in guarding the young otters.



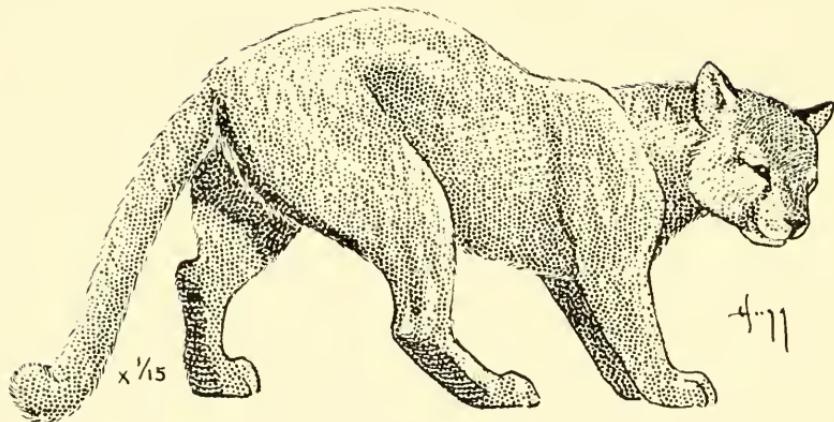
Description.—Measurements of eight males from California are: Total length, 1020-1164; tail, 335-507; hind foot, 110-138; weight, 11-23½ lbs. Females average slightly less than two pounds lighter and two per cent less in linear measurements. Skulls of a male and female from northern Nevada measure: basilar length, 101.2, 98.8; zygomatic breadth, 75.0, 70.5. Color deep dark brown; ears short; neck of nearly same diameter as head; tail so thick at base as to merge imperceptibly into body; legs short; feet large; toes fully webbed.

Lutra canadensis interior Swenk (Univ. Studies, Univ. Nebraska, 18(1):2, May 15, 1920) is the subspecies that occurred in Kansas. The type locality is Lincoln Creek, west of Seward in Seward County, Nebraska.

FAMILY FELIDAE

Genus *Felis* Linnaeus

Mountain Lion

Felis concolor (Linnaeus)

This big cat bears the names of Cougar, Panther, Painter, Puma, Cataamount and some others.

There has been some difference of opinion among naturalists as to whether the Mountain Lion always is silent or whether it does make some of the arresting cries that have been ascribed to it. When all of the accounts are brought together it seems that the animal sometimes does caterwaul.

Some of the earlier White Men in America are said to have reasoned that an animal capable of so hideous a cry at night must be a destroyer of human life. Ernest Thompson Seton, I think it was, wrote that the early historians, equipped with this idea, having a love of the horrible, and fortified with a few rare accounts of cougar ferocity, pictured the animal as a very demon of the woods, an insatiable man-eater, that lured brave men to destruction by simulating the cry of a woman or child in distress, and that then sprang on the would-be rescuer as a cat does on a mouse, and bore him away to be devoured at the top of some tall tree.

Actually the Mountain Lion has been so much pursued by men and dogs and has been so often shot at that the creature is exceptionally shy and wary. Before this shyness developed there were several instances in which wild Mountain Lions showed "affection" for, and interest in, man, behaving toward him much as do domestic cats. It is true that a half dozen or so attacks have been made on persons. Most of these were by Mountain Lions that mistook the person for a deer or were by lions that were rabid or otherwise ill. There are, nevertheless, a couple of recorded instances in which Mountain Lions attacked under circumstances indicating that a seemingly healthy lion decided to kill and eat a person. On the other hand there are thousands of persons who have slept on the ground, in the open, at night in country where Mountain Lions were common and without molestation. In many instances, as revealed by tracks, a Mountain Lion approached to within four or five yards of a sleeping person. The chances that such persons run of being harmed by Mountain Lions are somewhat less than their chances of being struck by lightning.

In many winters, Kansas newspapers carry accounts of a Mountain Lion having been seen in one or another part of the State. Most, and possibly all, such accounts of the past 50 years were based on nothing more than the desire of someone to write a story or on the too vivid imagination of someone who saw an animal or a track that he could not identify with certainty. Now, however, the White-tailed Deer is re-establishing itself in Kansas. Since deer are the principal prey of the Mountain Lion, that big, tawny cat might again find his way into our State.

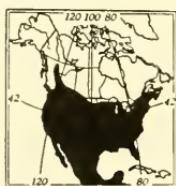
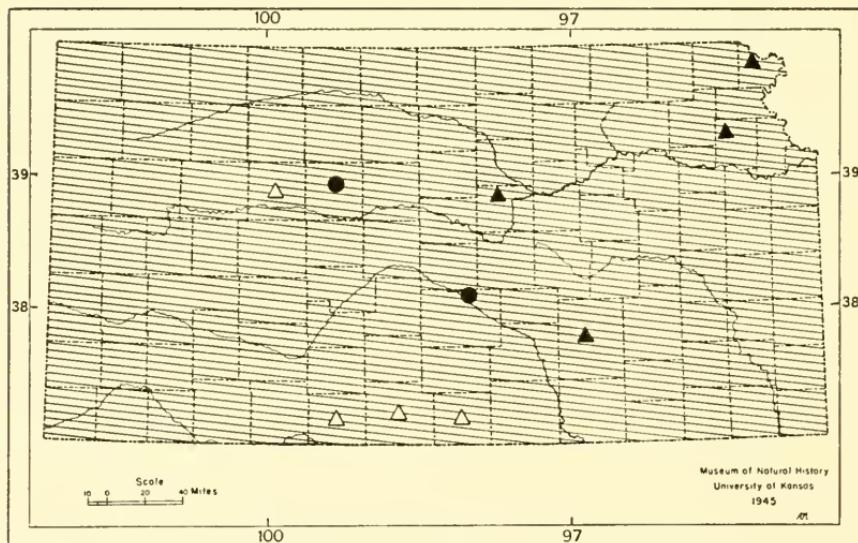
This species has a longer geographic range from north to south than does any other Kansas mammal; the range is from southern Canada all the way south to the southern tip of South America.

Many Mountain Lions have been caught as cubs and reared. These revealed much individual variation in temperament. Some proved unreliable as pets but many were wholly satisfactory. There are accounts of Mountain Lions thus kept by the Cheyenne Indians and used by them for hunting.

Deer are the prey most relied upon by Mountain Lions for food. After eating its fill from a freshly killed deer a Mountain Lion ordinarily, it is said, covers the remains with leaves, grass, sticks and similar debris and may return to feed two or three times more on the cached meat. Of domestic animals, colts when unattended

by man, are especially liable to be killed. The available evidence indicates that the Mountain Lion obtains deer mostly by creeping up to within a relatively short distance and then making a rapid dash involving one, two or three leaps.

The gestation period seems to be 96 days. There usually are two young in a litter but sometimes only one and sometimes as many as six. A young one weighs a pound or less at birth, 1/120th as much as the mother, opens its eyes on the seventh to tenth day of life, and has fine yellow fur abundantly marked with black spots that ordinarily disappear when the animal is approximately six months old. Young are born in caves, in hollows of huge logs, under cover of dense brush or under an overhanging bank.



At one time the Mountain Lion occurred throughout Kansas but has been extirpated in the State. The last free-living one of which there is record at the University of Kansas Museum of Natural History was taken on August 15, 1904, at Catherine, nine miles north of Hays. The animal is thought to have been a straggler from less settled country.

Description.—Young and Goldman in their book "The Puma . . . , Amer. Wildlife Institute, 1946," on page 210 record three males and three females from the vicinity of Meeker, Colorado, as follows: Total length, 2438, 2336, 2286; weight, 227, 164, 160 lbs.; females, 2134, 2058, 2006; weight, 133, 124, 120 lbs.; in male greatest length of skull, 237 and zygomatic breadth, 162.5; in female, 203 and 133.7. Tail amounts to slightly more than a third of total length; hind foot, 280 to 310 mm. Pelage tawny to grayish, color

most intense along mid-dorsal line; shoulders and flanks lighter; underparts dull whitish; ears and vibrissae pad black; upper lips, chin and throat nearly pure white. Four cheek-teeth (2 premolars and 2 molars) in each side of upper jaw.

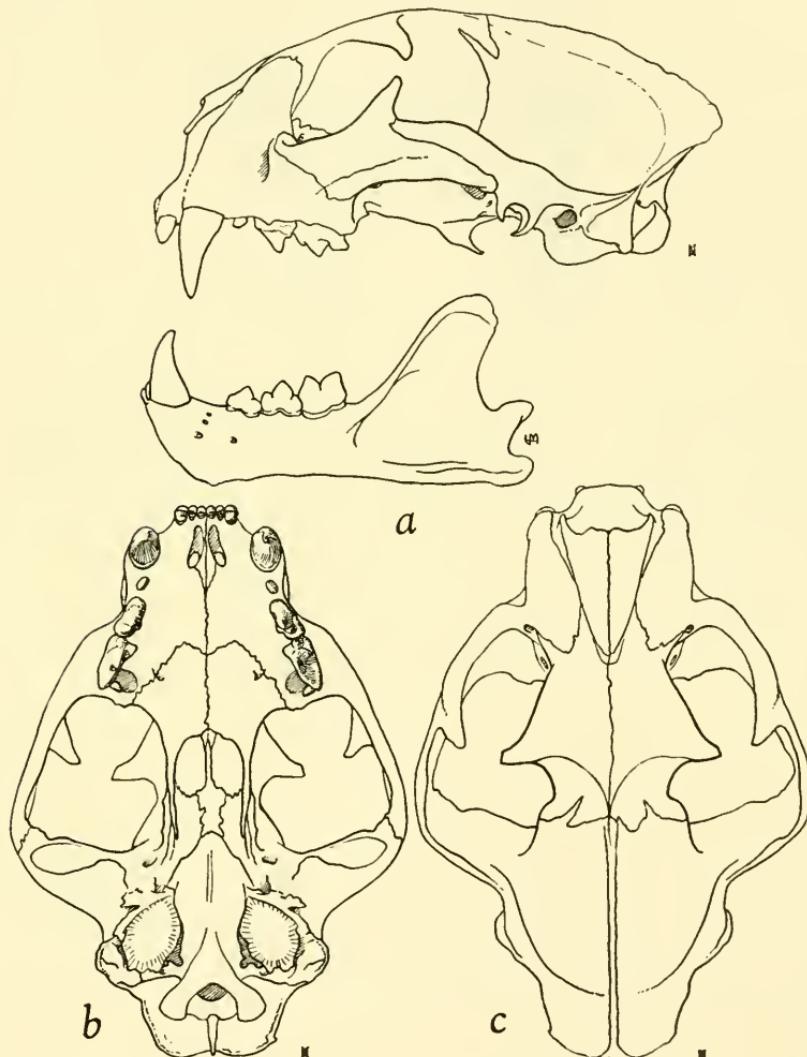
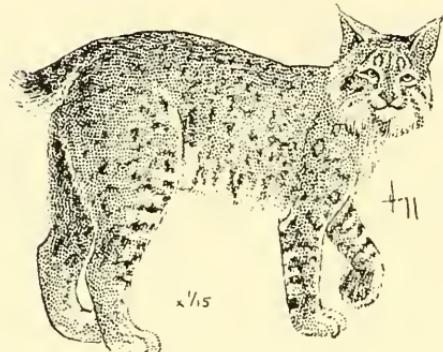


FIG. 67. Skull and left lower jaw of Mountain Lion, *Felis concolor* [subspecies *kaibabensis* Nelson and Goldman], Potts, Nye Co., Nevada, ♂, No. 37295 MVZ, $\times \frac{1}{3}$.

Felis concolor hippolestes Merriam (Proc. Biol. Soc. Washington, 11:219, July 15, 1897), with type locality near head of Big Windy River in the Wind River Mountains of Wyoming, is the subspecies to which the original population of Mountain Lion in Kansas currently is referred.

Genus *Lynx* Kerr

Bobcat

Lynx rufus (Schreber)

The Bobcat is primarily nocturnal but it prowls some in the daytime. One that I saw running left with me the impression of an animal that had tremendously long legs. Perhaps the shortness of the tail in some fashion emphasized the length of leg.

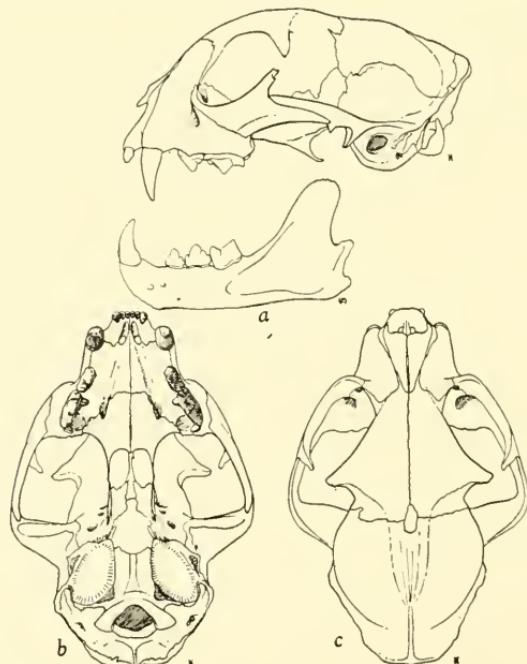
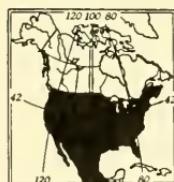
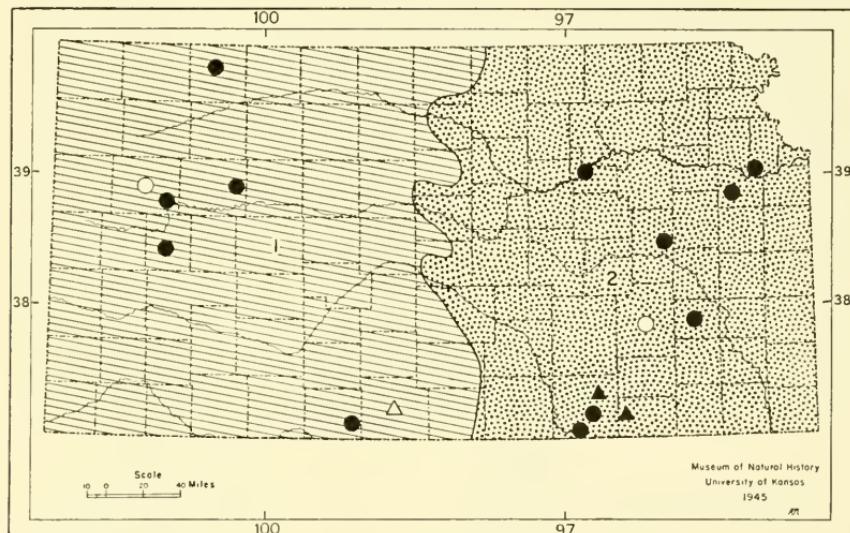


FIG. 68. Skull and left lower jaw of Bobcat,
Lynx rufus [subspecies *pallescens* Merriam],
Marble, Nye Co., Nevada, ♂, No. 24584 MVZ,
 $\times \frac{1}{3}$.

Exceptional individuals captured as small kittens are reported to have made satisfactory pets but most Bobcats, even when captured as small kittens, grow more unmanageable as they become older and have to be caged, or released before full grown.

Woodrats, pocket gophers, mice and other rodents are the principal food of Bobcats but they have been known to eat frogs, bats, birds and a wide variety of smaller animals.

There is a single litter of young each year, numbering two to four; three is the usual number.



Distribution of *Lynx rufus*.
1. *L. r. baileyi*. 2. *L. r. rufus*.

At one time the Bobcat occurred throughout the State but now is absent in most areas and rare in the others.

Description.—For two males from 2½ mi. SW Dexter and 2½ mi. SW Silverdale, Kansas, measurements are, respectively, as follows: Total length, 952, 1010; tail, 160, 138; hind foot, 195, 181; ear from notch, 80, 67; weights, 24 and 23½ lbs. Weights of three other males recorded by Cockrum (Univ. Kansas Publ., Mus. Nat. Hist., 7:265, 1952) are 34, 25, 31½ lbs. Skulls of a male and female from Douglas County measure: Basilar length, 110.6, 103.1; zygomatic breadth, 87.1, 85.7. Brownish gray with cloudings or spots of black; underparts, insides of legs, lips, eye-ring and tip of tail white, but some black spots on underparts; claws retractile; three cheek-teeth on a side, or 12 in all.

Lynx rufus baileyi, the subspecies in the western half of the State, was named by Merriam (N. Amer. Fauna, 3:79, September 11, 1890) with type locality at Moccasin Spring, Coconino County, Arizona. *Lynx rufus rufus* (Schreber), the subspecies in the eastern half of the State with type from New York was named on plate 109b of Säugethiere, 1777.

ORDER ARTIODACTYLA

Members of this order are referred to as the even-toed ungulates. The word ungual is derived from the Latin and refers to nail, claw, or hoof—in the present instance to the hoof. Even-toed refers to an even number of toes, two or four. The third and fourth toes are symmetrical to a line between them and support most of the weight of the animal. The other toes are reduced or absent depending on the species. The astragalus, a bone in the ankle, is grooved, somewhat as is a pulley, at each of the two ends and provides for movement at each of these ends. This flexibility, strictly in a fore and aft direction, in the ankle may be responsible for even-toed ungulates getting up rear end first, as a cow does, instead of front end first as a horse does. The horse belongs to the Order Perissodactyla in which the astragalus is grooved on only one end, and the ankle is less flexible. A perissodactyl supports nearly all of its weight on one toe, the third, of each foot, and is referred to as an uneven-toed ungulate. The Order Artiodactyla includes the pigs, peccaries, hippopotami, camels, musk deer, true deer, giraffes, antelopes, and bovids (cattle, bison, sheep and goats). The six groups named last are ruminants; freshly eaten food is returned from a special compartment in the stomach to be chewed and reswallowed.

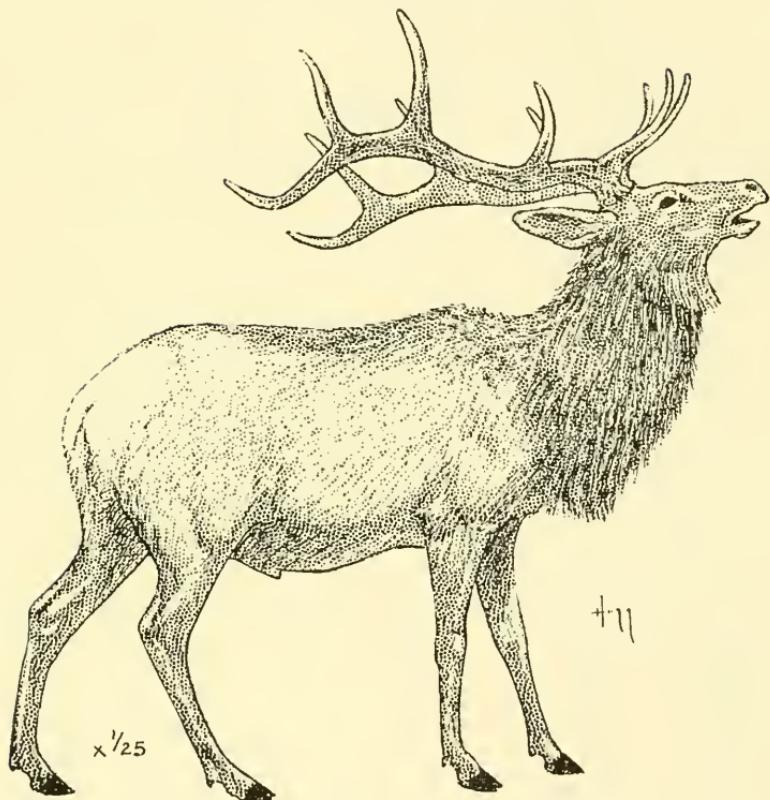
KEY TO ARTIODACTYLS

1. Males with antlers; females without antlers or horns.
2. Tail straw-colored; row of upper cheek-teeth more than 110 mm.; knoblike canine tooth at union of maxillary and premaxillary bones Wapiti (Elk), page 227
- 2'. Tail white with black tip, or tail brown; row of upper cheek-teeth less than 110 mm.; no canine tooth.
3. Tail brown on upper side and white on underside; ears approximately $\frac{1}{2}$ length of head; antler with one main beam and smaller tines branching from it White-tailed Deer, page 235
- 3'. Tail white, tipped with black tuft; ears approximately $\frac{2}{3}$ length of head; antler branching dichotomously (into two equal parts) Black-tailed Deer, page 230
- 1'. Males and females with horns; each horn with a bony core and horny covering.
 4. Underside of neck crossed by two white bars; horns with single fork in male (unforked in female); two hooves on each foot and rarely one additional vestigial hoof Prong-horned Antelope, page 239
 - 4'. Underside of neck uniformly brown without white bars; horns unforked; four hooves (including two vestigial hooves) on each foot American Bison, page 242

FAMILY CERVIDAE

Genus *Cervus* Linnaeus

Wapiti

Cervus canadensis Erxleben

The names Elk and Wapiti are used interchangeably for this species in America. The species occurs also in the Old World and is there referred to as the Red Deer. The big animal with palmate antlers that is referred to as Moose in North America also occurs in the Old World and is there referred to as Elk! Exactly how the name Elk was transferred to the American counterpart of the Red Deer I do not know. To avoid confusion, most American writers have used the name Wapiti for the American species here under consideration.

Even after it had been destroyed in eastern Kansas, the Wapiti was abundant in central Kansas and farther west. From 1859 to 1864

the eastern limit of the range of the Wapiti was a line drawn north and south through El Dorado, Butler County. In those times J. R. Meade saw a thousand or more in one band on the present site of the town of Lincoln. As late as 1866 W. A. Phillips saw several thousand Wapiti in a herd. J. A. Allen reported the species

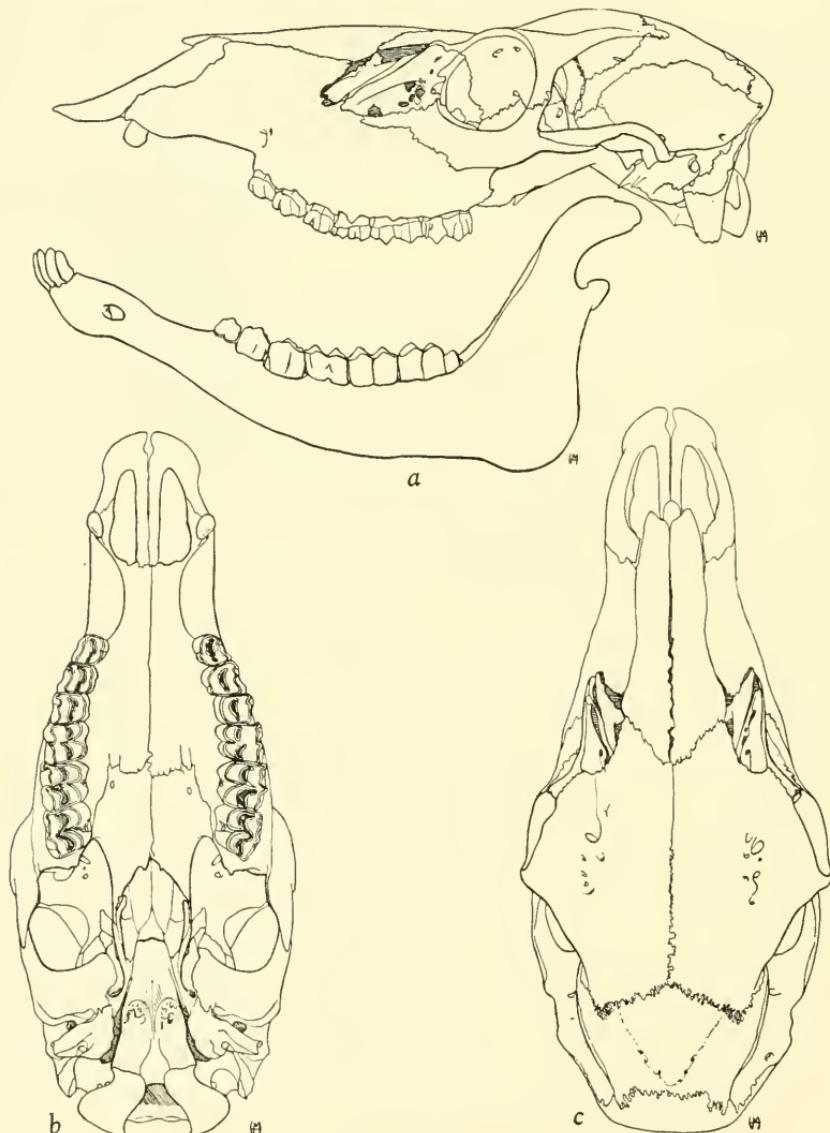
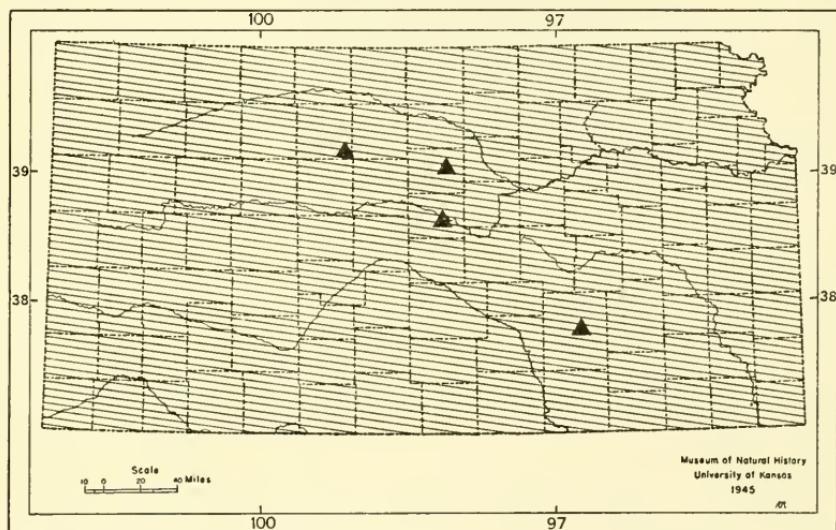


FIG. 69. Three views of skull and left lower jaw of Wapiti, *Cervus canadensis* [subspecies *nelsoni* Bailey], 1 mi. N Green River Lakes, 8300 ft., Sublette Co., Wyoming, ♀, No. 89267 MVZ, $\times \frac{1}{2}$.

as more or less common in 1871 on Paradise Creek and as occurring as far east as the present county of Ellsworth. As late as 1875 M. V. B. Knox reported the species as common in western Kansas.

The Wapiti, more than other deer, prefers grass but can subsist on forbs and even woody vegetation, congregates in herds, mates in autumn, and eight and a half months later has one calf—rarely twins. The calf is brownish prominently marked with white spots and at birth weighs 30 to 40 pounds. Three fourths of the females have calves for the first time when three years old; the other females have their first calves when older. In the breeding season males bugle. In summer both sexes seek out wet places and make mud wallows. Elk meat is delicious.

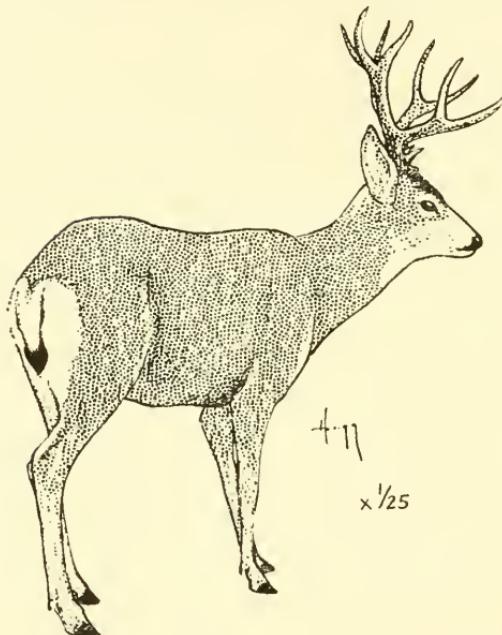


The Wapiti formerly occurred throughout the State but was extirpated well before the turn of the century.

Description.—Total length, 2500; tail, 125; hind foot, 700; ear from notch, 220; weight, 631 pounds (up to 1032). The female is slightly smaller, averaging 520 pounds. Basilar length of skull of male, 448; zygomatic breadth, 173. Head and neck dark brown; sides and back grayish brown; rump and tail lighter, straw colored; underparts blackish with white patch between hind legs; legs dark brown; neck maned. Only males possess antlers, which commonly have five to seven points including well-developed brow tine and bez tine; antlers, measured along beam, following curves, as much as 66 inches long, and in exceptional specimens with a spread of 60 inches; antorbital facial glands present; metatarsal gland oval, about three inches long, above middle of metatarsus; nose pad mostly naked and rough.

Cervus canadensis canadensis Erxleben (Syst. Regni Anim., 1:305, 1777) with type from eastern Canada is the subspecies that occurred in Kansas.

Genus *Odocoileus* Rafinesque
Black-tailed Deer
Odocoileus hemionus (Rafinesque)



This species "formerly occurred over much of western Kansas, at least during the winter . . ." according to Cockrum (Univ. Kansas Publ., Mus. Nat. Hist., 7:271-272, 1952) and he notes that, in 1859, J. R. Meade found the species to be numerous in winter in the hills between the Saline and Solomon rivers, going in bunches of up to 40 individuals. Meade supposed that they came down from the foothills of Colorado; he did not see them in summer. As late as 1866 W. A. Phillips saw small bunches among the bluffs and cedars of the upper Smoky, Saline and Solomon rivers and J. A. Allen reported the species as more or less common in 1871 in western Kansas along the streams that he designated as the Smoky and Paradise. In 1889 A. B. Baker reported that near Wakeeney, Trego County, this species was found only occasionally in the roughest country although the animals had been common only a few years before. Later writers reported this deer as extinct in Kansas but in 1937 when camped in the Meade County State Park where imported deer were kept in a fenced area, J. A. Tihen and J. M. Sprague recovered the fresh remains of a deer of this species from along the

Cimarron River on the plains north of Plains, Kansas, and thought that their specimen was "one of the few wild deer still found along the Cimarron Breaks." After presenting the above and other information Cockrum (*op. cit.*) relates that Black-tailed Deer from Meade County State Park were released in 1950 in Morton County.

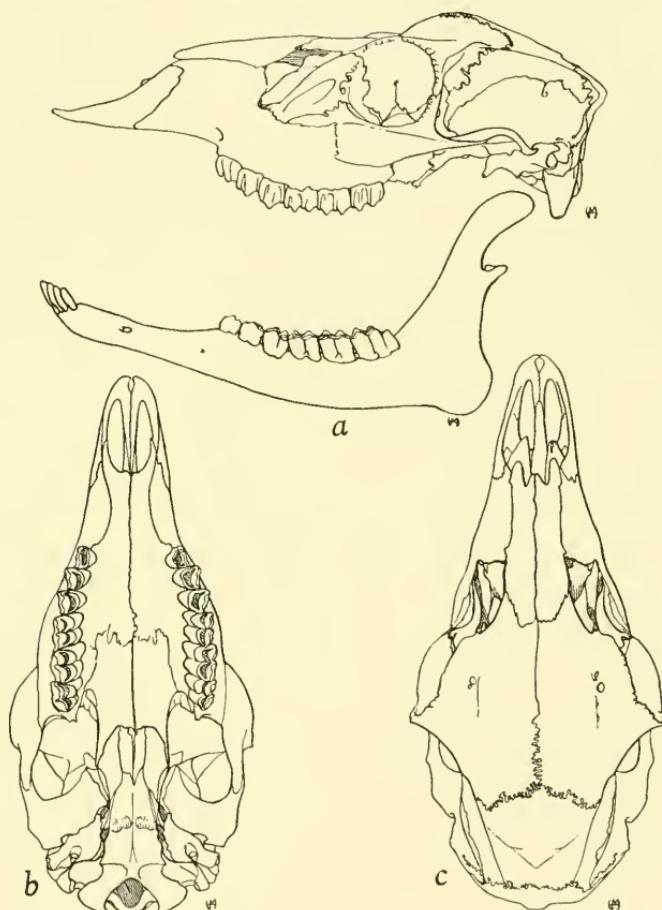


FIG. 70. Skull and left lower jaw of Black-tailed Deer, *Odocoileus hemionus hemionus* Rafinesque, 12-mile Creek, $\frac{1}{2}$ mi. E California boundary, Washoe Co., Nevada, ♀, No. 74295 MVZ, $\times \frac{1}{4}$.

This deer is the species common today throughout the western part of the United States. The subspecies that occurred in Kansas often is referred to as Mule Deer. It and other subspecies farther west make up the species *Odocoileus hemionus* for which the vernacular name, Black-tailed Deer, seems most appropriate.

A remarkable feature of the Black-tailed Deer, and of all members of the deer family, Cervidae, is the antlers. These are present in only the males in the Black-tailed Deer, White-tailed Deer and Wapiti. When the male Black-tailed Deer is three to three and one half months old a bulge appears above each eye on the frontal bone. By winter these protuberances may be three inches long and are covered by skin liberally supplied with normal hair. At this stage these frontal growths represent not only the pedicel, but also what, during the following summer, will develop into the first set of antlers. In the subspecies, of Black-tailed Deer, that ranged eastward into Kansas each of the first pair of antlers normally has one fork. This is shed in winter. From the border of the wound left by the shed antler a thin sheet of skin grows and in three days time covers the wound. Bony growth occurs underneath and the new antler is covered with velvet, a modified skin with velvetlike hair. The velvet remains until the antler is full-sized at which time the deer strips velvet off by vigorously rubbing the antlers on bushes and other objects. This results in a slight flow of blood but the superficial blood vessels by this time seem to have become constricted and so little blood is lost as to be of no consequence to the animal. Ossification (formation of bone) occurs on the outside of the antler first and gradually progresses inward taking place there even after the velvet has been shed. Finally the blood vessels that supply the center of the antler are closed and the antler then becomes a dead structure. The fully formed, polished antler is an offensive weapon. It is smaller and has fewer points in a young buck than in one that has reached full bodily development. In old age the number of points, and sometimes the size, tends to decrease; consequently the size of the antlers and the number of points on them are not at all sure guides to the age of the deer. In winter the bone between the pedicle and base of the antler breaks down and the antler breaks off, as a result of its own weight or from coming in contact with some other object.

The bounding gait of this species is not shared with the White-tailed Deer or with the Wapiti. Anyone who sees the bounding for the first time is impressed because it seems to be so effortless. The usefulness of this gait is made clear by Seton (*Lives of Game Animals*, 3:365, 1929) in describing how some greyhounds pursued a doe and her two fawns. "We did our best to call the hounds away. . . . The greyhounds . . . were making three yards to the . . . Deer's two. . . . The little ones were suffering

now, were weakening. It was a question of barely a quarter mile. Then we riders saw a thing that touched our hearts—that poor, devoted mother, in despair, dropped back behind—deliberately it seemed—at least her young should have a chance, and my blood rushed hot. My hand sought the gun in reckless determination to stop those Dogs. Only twenty-five yards ahead the mother now, when all at once an inspiration came. The unseen prompter whispered wisdom; and the mother turned aside, made for the rugged piling hills so near, she—all three—soon reached their base and tapped with their toes, then rose in air to land some fifteen feet above, and tapped again—and tapped and tapped all three; and so they rose and sailed and soared. The greyhounds reached the rise and there were lost; their kingdom was the level plain; on the rugged hills they were . . . left behind. But the mother and her two went bounding, soaring like hill-hawks, and so they sailed away till hidden in the heights, and safely at peace. . . . this pace is their gift, their power, and their hold on life."

On the Kaibab Plateau in northern Arizona where I saw this deer in the summer of 1925, the Mountain Lion and Coyote were its principal enemies. Twice I had described to me the vicious and successful defense by a doe of her fawn when a coyote approached it. Although Coyotes kill Black-tailed Deer in winter, even adult deer, the doe in defense of her fawn seems always to be more than a match for a single Coyote. The Coyote's best defense against the slashing blows of the doe's sharp-hooved forefeet is headlong flight.

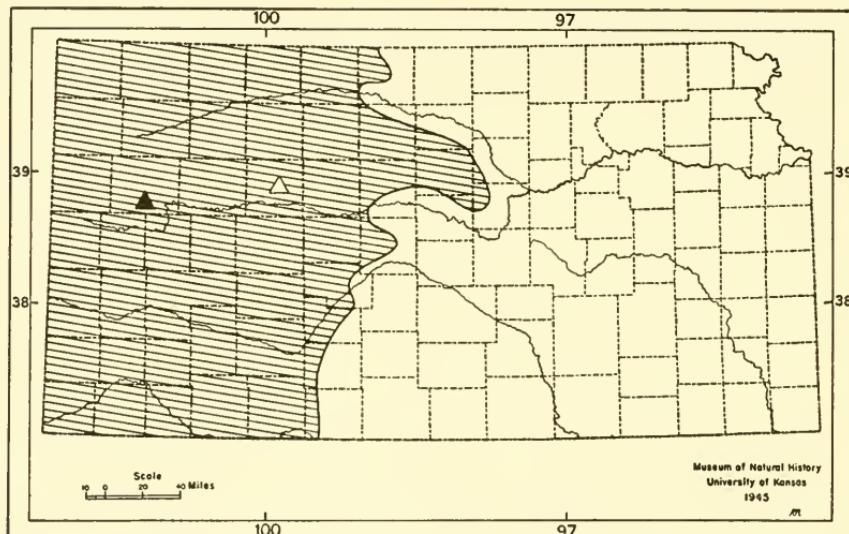
When roused from a thicket or from its bed a Black-tailed Deer, there in Arizona, almost always pauses for a look before dashing on out of sight. The does with fawns drink at least once, and usually twice, each day. Most of the does lie down from 8 to 4 in the daytime and feed before and after those hours. The Black-tailed Deer definitely is more of a browsing animal than a grazing animal. A large share of its food, therefore, is the leaves and twig-tips of shrubs and trees. It eats also forbs and some grass.

A female has one, two or three fawns. Until five weeks old the fawns remain hidden most of the time. When not nursing they lie quietly and do not flee until almost stepped on. The instinctive reaction, of a very young fawn, to danger is to drop to the ground and lie motionless.

Fawns and young of the Black-tailed Deer make excellent pets. Some full grown bucks, with sharp-pointed antlers, especially in

the rutting season, when the neck swells to large size, are unreliable and even though previously tamed are not to be trusted.

The breeding season is in November and December. After a gestation period of $6\frac{1}{2}$ to 7 months the spotted fawns are born in May or June. By September most fawns have lost their spots and are colored like adults.

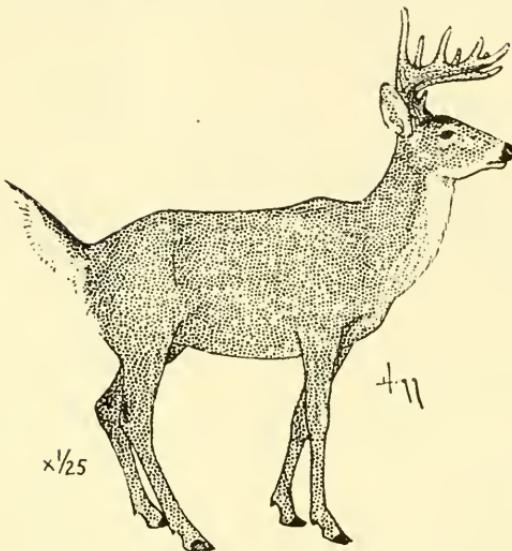


The Black-tailed Deer is thought not to occur in the wild state in Kansas today.

Description.—Measurements of a male and female, from Nevada, are as follows: Total length, 1710, 1555; tail, 134, 180; hind foot, 585, 480; males commonly weigh two hundred to three hundred pounds and exceptionally large males reach 456 lbs.; basilar length of skull, ♂ 258-285, ♀ 241-246; zygomatic breadth, 117-128, 107. Upper parts bluish gray in winter and reddish in summer; face dark brown with nearly white brow patch; brisket blackish on midline shading to gray on sides of chest; throat, genital region, rump, base of tail, and band completely encircling tail, white; axilla, inguinal region, belly, inside of forelegs and inside of hind legs to hocks, white with faint wash of fawn; tip of tail black; proximal half of tail naked below; metatarsal gland on inside of shank of hind leg 4 to 5 inches long and with two-thirds of its length above midpoint of shank; antlers branching dichotomously (evenly forking).

Odocoileus hemionus hemionus is the subspecies that occupied Kansas and was named by Rafinesque (Amer. Monthly Mag., 1:436, October, 1817), with type locality at the mouth of the Big Sioux River of South Dakota.

White-tailed Deer

Odocoileus virginianus (Boddaert)

This is the species of deer that inhabits the eastern half of the United States. It is a creature of the edge-environment; where glades in the timber, or brushy edges of woods, afford food, there is the habitat of the White-tailed Deer. As White Man pushed westward into the Great Plains he tended to follow the stream courses. Such courses furnished fuel, water for livestock and the best grass for the horses and oxen. The fringe of timber along such a stream was the habitat of the White-tailed Deer and it was among the first of the species of big game to be killed out in many areas of the Great Plains. This species, nevertheless, responds to game management excellently, as shown by its success in late years in the eastern United States; if the kill is regulated so that only a part of the annual increase is harvested, the species thrives in areas that are mostly devoted to agriculture. The small size of the home range is one circumstance that adapts the White-tailed Deer to thrive in thickly settled communities; a hundred acres of suitable habitat sometimes is enough to meet the needs of a deer. In an area devoted in the main to growing cultivated crops this species of deer, when abundant, can and does seriously damage some crops at certain times; orchards and melons are levied upon.

This deer, like the Blacktail, is more of a browser than a grazer. Twigs and leaves of brush and trees are the food eaten for most of the year but the White-tailed Deer feasts on acorns in autumn.

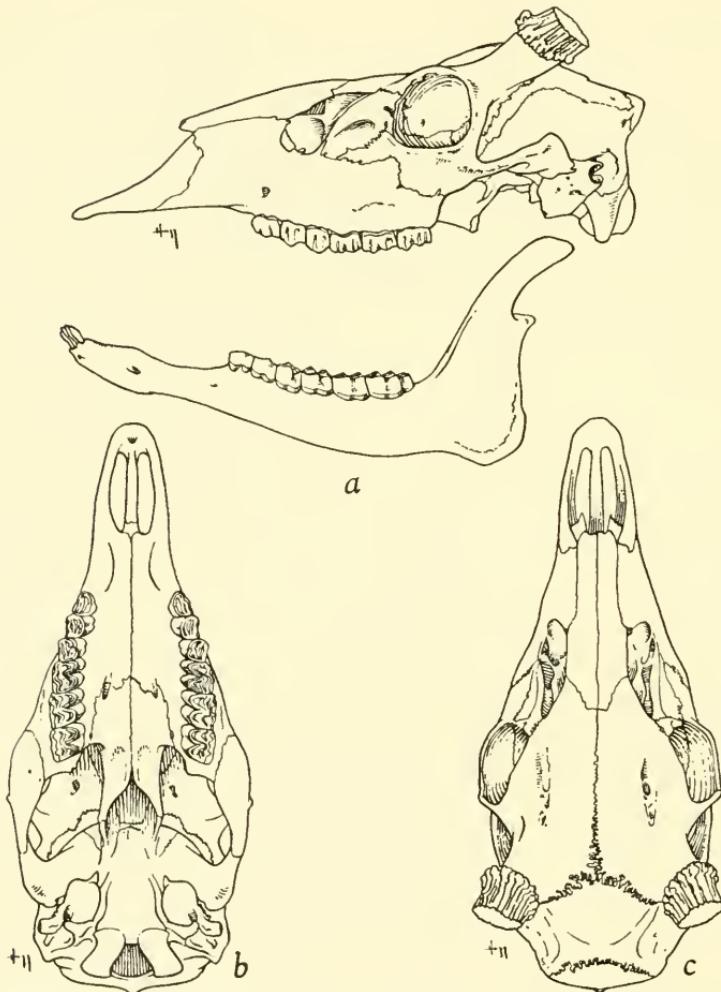


FIG. 71. Skull and left lower jaw of White-tailed Deer, *Odocoileus virginianus* [subspecies *texanus* (Mearns)], Encinal, Le Salle Co., Texas, ♂, No. 16538 KU, $\times \frac{1}{4}$.

The middle of November is the height of the rut. Then the antlers of the males are fully formed and polished; the neck of the male is much enlarged. Females have fawns when two or three years old. After a gestation period of 205-212 days the female bears one fawn or twins or triplets. At birth the fawn weighs

only 3½ lbs. It is bright bay or dull reddish brown marked with white spots. In the first days of life the fawns rely on concealment and immobility so much that, according to report, they feign death and permit themselves to be handled. When four to five weeks of age they begin to follow the mother.

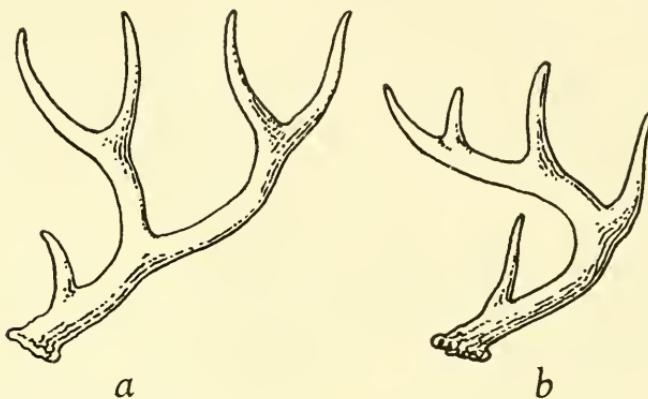
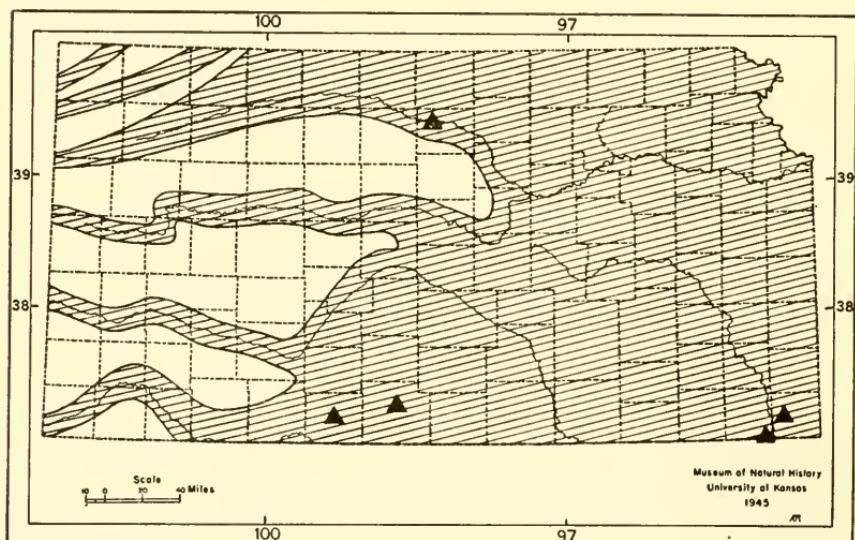


FIG. 72. Right antlers, of deer, viewed from inside, to show difference between antler of Black-tailed Deer, *a*, and White-tailed Deer, *b*. After Seton 1929. Note that the antler of the White-tailed Deer (*b*) has one main beam with minor prongs branching off of the same whereas the antler of the Black-tailed Deer (*a*) branches into two nearly equal parts.
X approximately $\frac{1}{6}$.

There are three external differences between the two kinds of deer in Kansas. The tail of the White-tailed Deer is long, wide, edged all around with white, often is held erect and thus reveals the all-white undersurface. The tail of the Black-tailed Deer (sub-species *O. h. hemionus*) is shorter, round and short-haired throughout most of its extent, provided with a black tip, and is not held erect. The metatarsal gland on the inside of the shank of the hind leg is scarcely an inch long in the White-tailed Deer and approximately five inches long in the Black-tailed Deer. The antler of the White-tailed Deer has one principal beam with secondary prongs branching off of it, whereas the antler of the Black-tailed Deer branches dichotomously; that is to say the antler branches into two beams of approximately equal size and each of these divides into two equal prongs.

When White Man first reached Kansas the White-tailed Deer occurred throughout the State in suitable habitat; the shaded area on the distribution map of Kansas represents the areas where we suppose the species was to be found. Cockrum (Univ. Kansas

Publ., Mus. Nat. Hist., 7:273, 1952) notes that J. R. Meade in 1859 found this species numerously in the hills about the forks of the Solomon River and the hilly country of Barber and Comanche counties. As late as 1875 M. V. B. Knox reported White-tailed Deer as frequent in large bodies of timber in different parts of the State. Ross McDonald killed a doe at Chetopa, Labette County, in 1881 and Dave Dunham killed a buck on Lightning Creek near Columbus, Cherokee County, in 1896. In 1905 D. E. Lantz thought the species was extinct in the state and C. W. Hibbard in 1933 and 1944 held the same opinion. Since 1945, however, there have been increasing numbers of White-tailed Deer in the eastern half of Kansas.



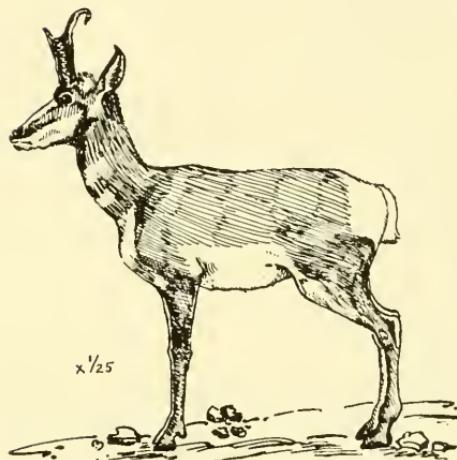
Description.—Seton (Lives of Game Animals, 3:231, 1929) gives measurements of a typical male as: Total length, 1826; tail, 152; hind foot, 488, and states that the female is "about a quarter less." Two hundred pounds is common for males and the maximum is estimated at 422 pounds (354 pounds dressed). Basilar length of skull, 230-250; zygomatic breadth, 107-113 of male. Upper parts gray (salt and pepper effect) in winter and reddish tan in summer; darker down center of upper side of tail; chin with black spot on each side; band across nose, ring around each eye, inside of each ear, patch on throat, inside of each leg, edging and underside of tail, and belly white; metatarsal gland scarcely one inch long; antlers with smaller prongs branching off of one main beam.

Odocoileus virginianus macrourus named by Rafinesque (Amer. Monthly Mag., 1:436, 1817) with type from plains of Kansas River, upper Mississippi Valley, is the subspecies thought to have occurred originally in Kansas.

FAMILY ANTILOCAPRIDAE

Genus *Antilocapra* Ord

Prong-horned Antelope

Antilocapra americana (Ord)

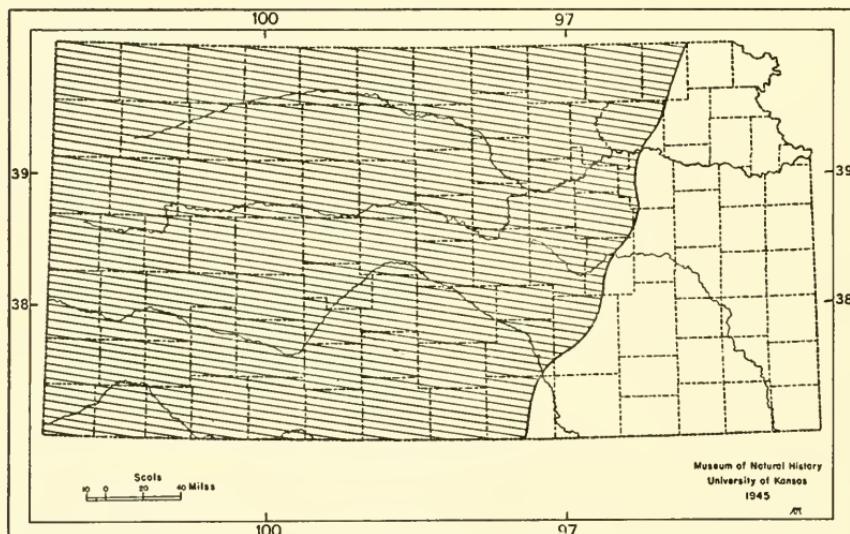
The speed of the Pronghorn exceeds that of any other kind of North American big game. Individuals have been timed at speeds in excess of 60 miles per hour. Like some other species of big game the Pronghorn will race parallel to a moving auto and cross in front of it. In my experience (in Nevada and Wyoming) in summer it occurs singly or more often in small bands of up to twenty. In autumn and winter it is said to congregate in larger bands.

Whereas the many true antelopes of Africa belong to the cow-bison family, Bovidae, the Prong-horned Antelope of America is the sole living representative of its family, Antilocapridae. The Pronghorn annually sheds (in late October or early November) the sheaths of its horns each of which has a permanent (unshed) bony core. This bony core with a horny covering corresponds to the arrangement in the Bison, cattle and true antelopes but the latter animals do not shed the sheath. This annual shedding corresponds to the arrangement in the deer family, Cervidae, but those animals have antlers (no core and covering) which are shed in their entirety by parting from the skull at the hair line. Thus, it is seen that the Pronghorn combines, in a sense, the features of the cattle and deer. The Pronghorn, however, has additional distinctive structural features which fully entitle it to rank as a separate

family. For one thing the forefeet are larger than the hind feet! There are no dew claws. The hair is long, coarse and made up of large air cells; each hair, in a sense, is a miniature thermos bottle and when the hairs are laid flat they effectively insulate the animal by excluding the cold and by retaining the animal heat in the body. When the hair is raised, as it may be in hot weather, it allows the animal heat to be dissipated. On the rump the hair is four inches long and flashes white when erected.

The Pronghorn subsists mainly on browse plants such as sage-brush. Weeds of several kinds are second choice. Grass is third.

The female breeds when 14 to 16 months of age and after a gestation period of 230 to 240 days has one fawn, or more often twins. For the first five days of its life the fawn lies prone most of the time. As it grows older it spends more and more time with other individuals of its own kind.



The shaded area on the distribution map of Kansas shows what we suppose was the eastern limit of the species when White Man first came to Kansas. Pike, in 1806, found the Prong-horned Antelope to be common in eastern Kansas (see Cockrum, Univ. Kansas Publ., Mus. Nat. Hist., 7:274-275, 1952). Successively later observers found the eastern boundary of the animal's range at places progressively farther west. The late Charles Dean Bunker saw three in Stanton County in 1912 but in 1933 Claude W. Hibbard wrote that the animal had not been seen in Kansas in the past few years. In 1953 Mr. August Lalouette in Marion County had a young one that had been imported from Montana and in 1954 brought in 13 more from the same state.

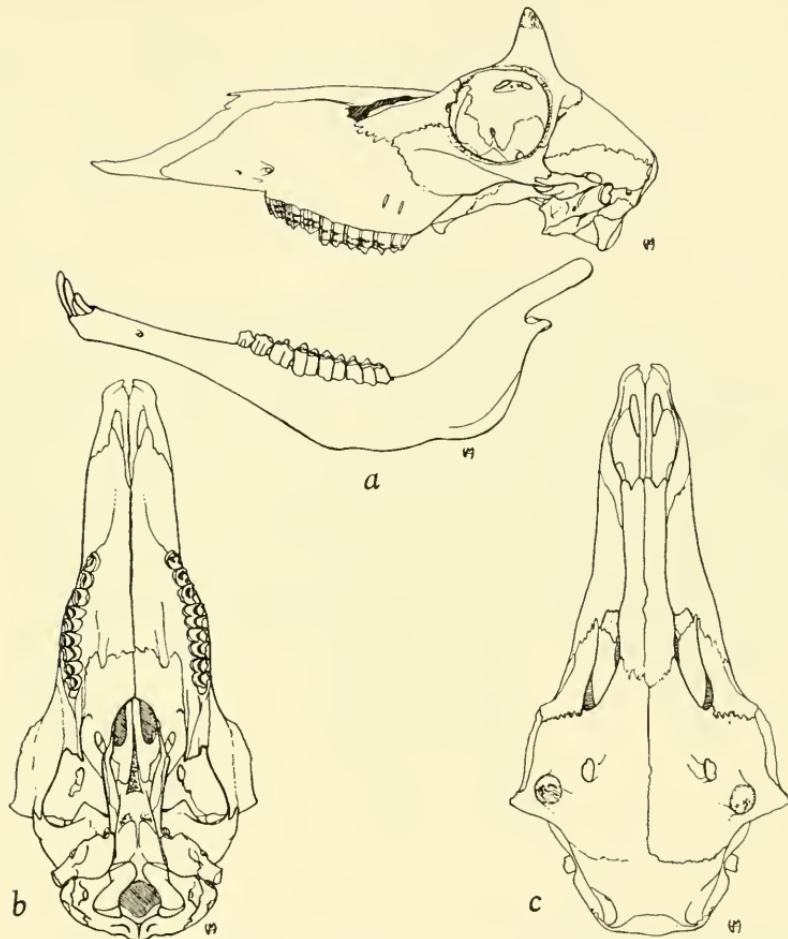


FIG. 73. Skull and left lower jaw of Prong-horned Antelope, *Antilocapra americana americana* (Ord), 13 mi. N and 6 mi. W Deep Hole, Washoe Co., Nevada, ♀, No. 93881 MVZ, $\times \frac{1}{4}$.

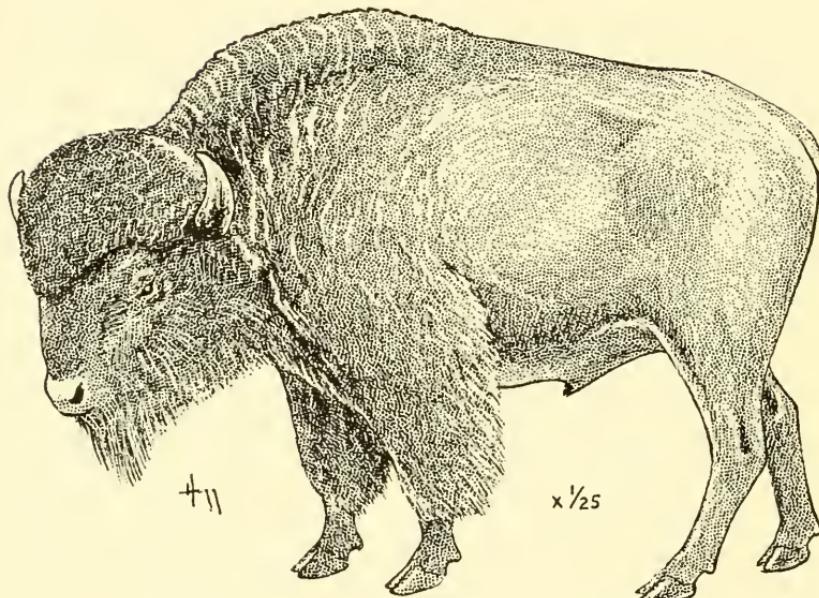
Description.—An adult female from the Granite Range, Washoe County, Nevada, measured: Total length, 1423; tail, 134; hind foot, 425; weight, 105½ lbs. Males are said to average 114 lbs. and to weigh up to 138 lbs. Basilar length of skull, 247-256; zygomatic breadth, 102.0-109.0. Body brown with strong tinge of cinnamon, darker on mane and paler on legs and ears; muzzle, eyelashes, spots over anterior angle of each eye, edges of ears at tips, and in many males a spot at each angle of jaw, black or blackish; forehead dark grayish; crown and nape dull brownish; cheeks and lips white; much white on throat, ears, sides, underparts and rump; four inguinal mammae; horns average 6 to 10 inches high in males and 2 inches in females; horn sheaths forked in males and unforked in females, shed annually; bony horn-core in each sex persistent (not shed), not forked.

Antilocapra americana americana is the subspecies that occurred in Kansas and was named by Ord (Guthrie's Geography, 2nd Amer. ed., 2:292 [described on p. 308], 1815) from the "Plains and highlands of the Missouri" River.

FAMILY BOVIDAE

Genus *Bison* Hamilton Smith

American Bison

Bison bison (Linnaeus)

It has been estimated that there were 60,000,000 Bison in North America when White Man came to that Continent. By 1895 there seem to have been fewer than a thousand individuals alive and they were in parks and preserves in different parts of the world. The number has increased since that time. The American Bison was a grazing, not a browsing, animal. Most of the huge herds were migratory to some degree; it is thought that they moved south two to four hundred miles in late autumn and thus wintered under circumstances more favorable than obtained farther north.

In spring and summer it was the habit of the Buffalo to paw up the turf and wallow in these spots to assist in shedding its hair and to dust the skin with loose earth to rid itself of flies and vermin. From repeated use and from wind that blew some of the loose earth away, such a buffalo wallow might become 30 feet in diameter and two feet or more in depth. I remember one of this size pointed out to me by my father in 1910 on the east forty of

our farm in Franklin County, one and a half miles south and a half mile east of Le Loup, Kansas. The wallow was a half mile from the nearest permanent water. These huge saucers collect rain in wet seasons. I have wondered if the fairy rings of mushrooms have some relation to these wallows. The dry hard fecal material, "buffalo chips," was a conspicuous feature of the prairies and made useful fuel for travelers, and even homesteaders, on the treeless plains.

To such Indians as the Comanche, Sioux and Cheyenne the Buffalo were essential and the passing of the Buffalo spelled disaster for these Indians and their way of life. From the Buffalo the Indian derived his food, shelter, clothing and implements. The hides were dressed in a variety of ways depending on the use to which they were to be put as moccasins, shields, clothing, tepee covers, covering of boats, for weaving into ropes, skin-boxes for holding food and other articles. Of the bones the shoulder blade was used as a hoe and the ribs as runners for small sleds pulled by dogs; other bones were made into arrow straighteners. The hooves were used in making glue. The list could be extended to hundreds of items; almost every part of the Buffalo was used for some purpose. When broken treaties caused Indian troubles it was sometimes the deliberate aim of the invading Whites indirectly to destroy the Indians by exterminating the Buffalo.

The Whites made relatively little use of the Buffalo. Of course the early travelers relied on it for food and for some other purposes but the settlers found the Bison incompatible with their farming and cattle raising. If the Bison had not already been exterminated by the hide hunters, the settlers completed the extinction process. Some idea of the vast numbers killed is to be had by noting that in the first winter that the Atchison, Topeka and Santa Fe Railroad reached Dodge City, the firm of Rath and Wright shipped more than 200,000 Buffalo hides. Other firms shipped as many more. In 1873 two thirds of the population of 4,000 persons in Dodge City were said to be Buffalo hunters. They overstocked the market with skins and the price dropped to \$1.25 per skin. Buffalo robes for winter use in buggies and sleighs were standard equipment during the past century in America. After the slaughter here, one man shipped more than three thousand cars of Buffalo bones in two years from Dodge City and made a large fortune. From 1868 to 1881 there was paid out in Kansas alone \$2,500,000 for Buffalo bones, gathered on the prairies, to be used by the various carbon works of the Country. The newer

bones were prepared for use in refining sugar and the old weather-beaten bones were ground up for fertilizer. The late Handel T. Martin, Assistant Curator in Vertebrate Paleontology at the Museum of Natural History at the University of Kansas, homesteaded in western Kansas, and received his mail there at Elkader. In or about 1922 he told me that in one or two drought years there, the gathering and selling of Bison bones yielded enough income to some of the homesteaders to permit them to remain in the area.

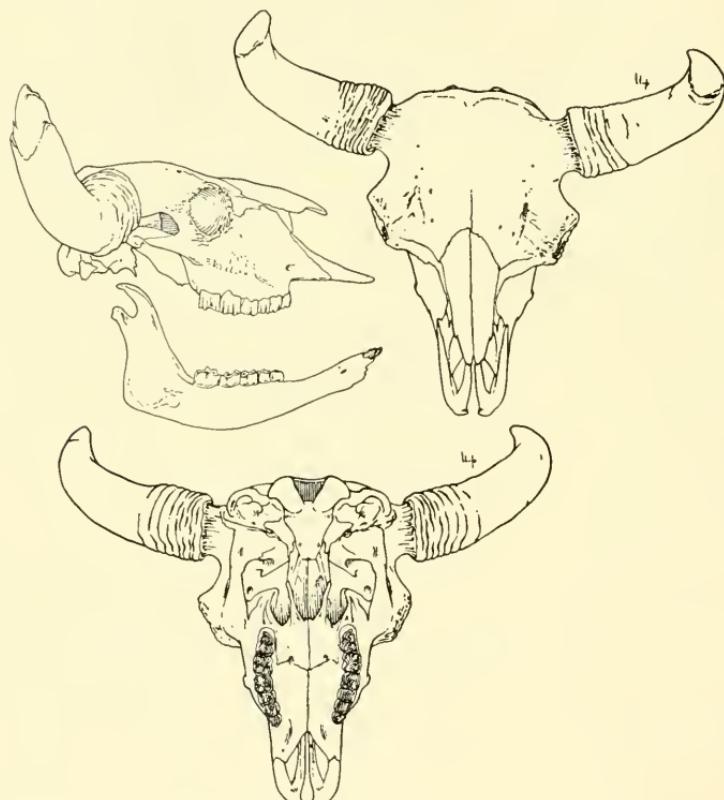


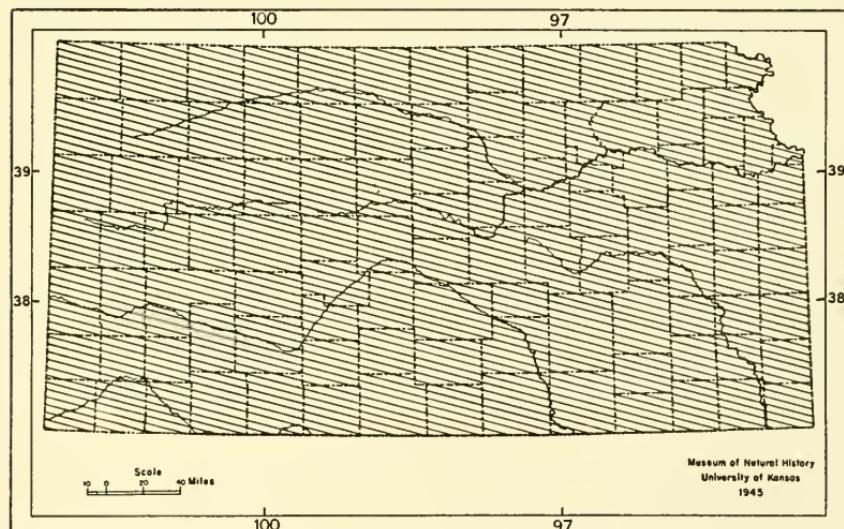
FIG. 74. Skull and left lower jaw of Bison, *Bison bison bison* Linnaeus, Buffalo Nat'l Park, Wainwright, Alberta, ♂, No. 48115 KU, $\times 1/12$.

It is my impression that he was one of those who profited from the bones. As I remember his account, most of the other homesteaders, as well as himself, eventually were forced to leave. In retrospect it seems that they were attempting agricultural operations not adapted to that part of the relatively arid Great Plains.

After a gestation period of nine and a half months the calf is born in April, May or June. Rarely there are twins. The new

born calf is bright yellow to tawny. Growth continues until the animal is seven or eight years old. The normal span of life is 25 to 30 years and many live to be older. Two cows, in the Good-night herd, calved when they were known to be 28 years old. Old cows remain with the herd. Some old bulls become solitary.

The last wild Bison in Kansas was killed in 1879 at Point of Rocks west of Dodge City along the Old Santa Fe Trail "near where the old and new trails join" according to M. S. Garretson (*The American Bison*, New York Zool. Soc., 1938, page 125). Cockrum (*Univ. Kansas Publ., Mus. Nat. Hist.*, 7:277, 1952), however, indicates that some Bison persisted until the winter of 1885 in the western counties but were exterminated before 1889.



Description.—Mature bulls reach a length of 9 to 11 feet (approximately 2 feet of this being the tail) and weigh 2000 to 3000 lbs.; cows weigh approximately half as much. Maximum size of horns: 22 $\frac{1}{2}$ inches on outside of curve; 14 $\frac{1}{2}$ inches in circumference at base; spread 35 $\frac{1}{2}$ inches (Garretson, *op. cit.*: 202). Head, tail, legs, lower parts of neck, and shoulders dark brown; becoming lighter brown on upper parts of body and palest on shoulders and hump. By spring the pelage has bleached to a dull yellowish brown although the head seems black in comparison with the body. Beard 8 to 10 inches long. Head seems relatively large because hair longer there than on body; huge hump, above shoulders, supported by elongated neural spines of thoracic vertebrae; hump nearly truncate anteriorly and sloping gradually posteriorly.

Bison bison bison is the subspecies of the Great Plains, including Kansas, and was named by Linnaeus (*Systema Naturae*, ed. 10, 1:72, 1758).

SPECIES OF UNVERIFIED OCCURRENCE

DESERT SHREW, *Notiosorex crawfordi* (Coues)

This species possibly occurs in southern Kansas; the species has been taken in Arkansas, Oklahoma, Texas and Colorado.

GRAY MYOTIS, *Myotis griseescens* (Howell)

This bat probably occurs in Kansas, at least in summer, in the southeastern part of the State. The species has been taken in Missouri and Oklahoma.

SOCIAL MYOTIS, *Myotis sodalis* Miller and Allen

This bat occurs in Boone County, Missouri, and Benton County, Arkansas, and therefore is to be expected in southeastern Kansas.

ROCK SQUIRREL, *Spermophilus variegatus* (Erxleben)

Young, in search of new homes, in late summer or early autumn conceivably could wander into SW Kansas from Otero Co., Colorado or Beaver Co., Oklahoma, but would find no permanent habitation.

CHESTNUT POCKET GOPHER, *Cratogeomys castanops* (Baird)

Specimens were taken two miles west of the Kansas State boundary at Monon in Baca County, Colorado. In Meade County, Kansas, two skulls that may be subfossils were found.

RICE RAT, *Oryzomys palustris* (Harlan)

In the U. S. Nat'l Museum, Neosho Falls is on the label of a specimen taken in 1859 by B. F. Goss but no specimen has been taken in Kansas since.

RING-TAILED CAT, *Bassariscus astutus* (Lichtenstein)

This small relative of the Raccoon probably occurs naturally in Cowley County. In 1952 Cockrum (Univ. Kansas Publ., Mus. Nat. Hist., 7:283, August 25) states that "W. C. Justice (*in litt.*) has reported to me that within the past eleven years six 'Texas ring-tailed cats' have been taken in Cowley County."

LEAST WEASEL, *Mustela rixosa* (Bangs)

This diminutive weasel almost certainly occurs in north-central Kansas. It has been taken in adjoining counties of Nebraska.

HOG-NOSED SKUNK, *Conepatus mesoleucus* Lichtenstein

Stragglers may reach SW Kansas from Colorado or Oklahoma. Differs from Striped Skunk (*Mephitis mephitis*) in: back all white; claws much larger; 3 (not 4) upper teeth behind each canine tooth.

REFERENCE BOOKS AND LITERATURE ON MAMMALS.

As a person's interest in mammals grows he will wish to consult the information that already has been published—concerning a particular kind of mammal in which he is interested or concerning a group of mammals or mammals in general. Fortunately this is easy to do. The best means of beginning is to subscribe to the *Journal of Mammalogy*. It is issued four times each year and contains articles on all phases of mammalogy. In every issue there is a list of recent literature which permits the reader to keep up to date on what is being published elsewhere than in the *Journal* itself. Two indices have been published to the contents of the *Journal of Mammalogy*. One is for the period 1919-1939 (volumes 1-20 inclusive) and the second is for the period 1940-1949 (volumes 21-30 inclusive). To find all that has been published in this *Journal*, on a given kind of mammal, a person has only to consult the proper heading in the two indices. Single numbers of the *Journal of Mammalogy* are \$1.50 each. Membership (\$4.00 per year) in the American Society of Mammalogists carries with it the right to receive the *Journal of Mammalogy* free. Orders for numbers of the *Journal* or applications for membership should be sent to the Corresponding Secretary of the American Society of Mammalogists. Persons actively interested in mammalogy can become members of the Society upon nomination (by the Secretary or other member), payment of membership dues, and election. Any librarian can provide the address of the Corresponding Secretary.

Of course there are a number of popular guide books designed to assist beginners in identifying kinds of mammals. These books, or at least the names of the publishers from whom they can be purchased, can be obtained at the local library or from any bookseller. One comprehensive treatise is "The Quadrupeds of North America" by John James Audubon and John Bachman, in three volumes, 1856, published by V. G. Audubon. This fine work can be obtained only as a second hand item. "Lives of Game Animals" by Ernest Thompson Seton, in four volumes, 1929, has recently been republished and is available through any bookseller. It contains life-history information presented in a popular style on many species of mammals that are non-game as well as on kinds that are game mammals.

The interested person will quickly discover that almost every book or article on mammals makes reference to others on the same subject. By looking up these references, a person can soon familiarize himself with the literature on mammals.

ILLUSTRATIONS

Mr. Victor Hogg made most of the drawings for the booklet on the mammals of Kansas. Miss Lucy Remple, however, prepared most of the miniature maps showing the ranges of species in North America. Forty-nine of the maps showing the geographic distributions of mammals in Kansas are from Cockrum (*Univ. Kansas Publ., Mus. Nat. Hist.*, Vol. 7, No. 1, 1952).

MAPS

The account of each species is accompanied by two maps. The smaller map shows the range in North America of the species. The second map is an outline of the state of Kansas, on which exact localities of occurrence are represented by circles and triangles. The total of the shaded area shows the presumed range in Kansas of the species. The geographic range of each subspecies, where more than one is recognized in the State, also is shown on this map.

The symbols for locality records are as follows: Circles denote places from which specimens were examined by Cockrum or me; triangles denote places from which specimens have been reported as occurring although no specimens have been examined from these places by Cockrum or me; hollow symbols denote localities known only to county. In some instances several localities that are close together have been represented by a single symbol to avoid overlapping, or undue crowding of symbols. Unless otherwise noted in text, records of occurrence on distribution maps are from Cockrum (*op. cit.*).

OTHER DRAWINGS

A word of explanation concerning the drawings of skulls is in order. For many of the species of the mammals of Kansas I had in my files drawings made in earlier years to illustrate other publications. Several of these have here been used even when the subspecies were not the same as that in Kansas. So doing lost nothing in clarity of illustrating the characters of the species and saved much expense and considerable time in providing illustrations. The precise provenance of each specimen thus illustrated is of course clearly indicated in its legend and furthermore brackets set off the subspecific names of those which are of subspecies that do not occur in Kansas.

Grateful acknowledgment is hereby made to those who have given permission to use illustrations that have been published elsewhere. Unless otherwise indicated below, the drawings of mammals are by Mr. Victor Hogg.

SOURCES OF DRAWINGS OF MAMMALS

Opossum.—From a variety of sources.

Short-tailed Shrew.—After Grossenheider by Lucy Remple (*The Mammals of Michigan*. By W. H. Burt. *The Univ. Michigan Press*, p. 102, fig. 62, 1946).

Little Short-tailed Shrew.—After Grossenheider (Burt, *op. cit.*: 99, fig. 61).

Eastern Mole.—From life, 2 mi. E Eudora, Kansas, November, 1952.

Big Myotis.—From frontispiece (photo) of "Bats" by G. M. Allen. *Harvard Univ. Press*, 1939.

Cave Myotis.—Modified from Big Myotis above.

- Small-footed Myotis.—Modified from Big Myotis above.
- Keen's Myotis.—Modified from Big Myotis above.
- Pipistrelle.—Modified from Big Myotis above.
- Big Brown Bat.—From life, Lawrence, Kansas, December, 1953.
- Evening Bat.—Modified from Big Myotis above.
- Silvery-haired Bat.—Modified from photo (Mammals of Indiana. By M. W. Lyon, Jr., Amer. Midland Nat., 17(No. 1):69, fig. 21, November, 1936).
- Hoary Bat.—After Grossenheider (Burt, *op. cit.*:Pl. 4).
- Red Bat.—After a drawing by L. A. Fuertes.
- Long-eared Bat.—Modified from Poole (The Mammals of Eastern United States. By W. J. Hamilton, Jr. Comstock Publ. Co., Inc., p. 105, fig. 52, 1943).
- Pallid Bat.—After a drawing by L. A. Fuertes.
- Brazilian Free-tailed Bat.—From a photo by V. Bailey.
- Big Free-tailed Bat.—Modified from Brazilian Free-tailed Bat above.
- Man.—From photo (Handbook of Aboriginal American Antiquities, Pt. 1. By W. H. Holmes. Bull. Amer. Ethnology, 60:287, 1919).
- Nine-banded Armadillo.—From specimen No. 19903 KU, ♀, 15 km. SW Jimba, 750 ft., Veracruz, Mexico.
- Eastern Cottontail.—Adapted from Fuertes (The Little Burgess Animal Book. . . . By T. W. Burgess. Rand McNally and Company, p. 7, 1920).
- Desert Cottontail.—Modified from Eastern Cottontail above.
- Swamp Rabbit.—Adapted from Fuertes (Burgess, *op. cit.*:p. 9).
- White-tailed Jack Rabbit.—From a variety of sources.
- Black-tailed Jack Rabbit.—After a drawing by L. A. Fuertes.
- Gray Squirrel.—After a drawing by L. A. Fuertes.
- Fox Squirrel.—Adapted from Cover painting of this booklet.
- Woodchuck.—From specimen, No. 3906 KU, ♂, Geary, Doniphan Co., Kansas.
- Black-tailed Prairie Dog.—From study specimen, No. 10308 KU, ♂, 2 mi. N Coolidge, Hamilton Co., Kansas.
- 13-lined Ground Squirrel.—From a variety of sources.
- Spotted Ground Squirrel.—After Seton (Revision of the North American Ground Squirrels. . . . By A. H. Howell, N. Amer. Fauna, 56, Pl. 5, 1938).
- Franklin's Ground Squirrel.—After Seton (A. H. Howell, *op. cit.*, Pl. 6).
- Eastern Chipmunk.—From mental image based on many sources and study specimens.
- Southern Flying Squirrel.—From a variety of sources.
- Plains Pocket Gopher.—Modified from P. and G. Mattson (Mammals of Lake Tahoe. By R. T. Orr. California Acad. Sci., p. 87, 1949).
- Plains Pocket Mouse.—From study specimen No. 50137 KU, ♀, 1 mi. S Parks, Dundy Co., Nebraska.
- Silky Pocket Mouse.—From Photo (Mammals of New Mexico. By V. Bailey. N. Amer. Fauna, 53, Pl. 12, fig. B, 1932).
- Coarse-haired Pocket Mouse.—Modified from Grossenheider (A Field Guide to the Mammals. By W. H. Burt and R. P. Grossenheider. Houghton Mifflin Co., Pl. 13, 1952).
- Ord's Kangaroo Rat.—Modified from photo (Locomotion in Kangaroo Rats and its adaptive Significance. By G. A. Bartholomew, Jr., and H. H. Caswell, Jr. Jour. Mamm., Vol. 32, Pl. 2, 1951).

- Beaver.—After Mary M. McAllister (*Mammals of Nevada*. By E. R. Hall. Univ. California Press, Berkeley, p. 98, 1946).
- Northern Grasshopper Mouse.—After a drawing by L. A. Fuertes.
- Fulvous Harvest Mouse.—From study skins in Museum.
- Western Harvest Mouse.—From study skins in Museum.
- Plains Harvest Mouse.—From study skins in Museum.
- Deer Mouse.—From life, Lawrence, Kansas, 1953.
- Woods Mouse.—Modified from Deer Mouse above.
- Brush Mouse.—Adapted from Grossenheider (*Burt and Grossenheider, op. cit.*, 16).
- Hispid Cotton Rat.—From photo (*Hamilton, op. cit.*:298, fig. 138).
- Eastern Wood Rat.—From life, 5 mi. S Lawrence, Kansas, October, 1953.
- Gray Wood Rat.—Modified from Eastern Wood Rat above.
- Southern Lemming Mouse.—Grossenheider (*A Synopsis of the North American Rodents*. By E. R. Hall and E. L. Cockrum. Univ. Kansas Publ., Mus. Nat. Hist., 5:474, fig. 124, 1953).
- Muskrat.—Grossenheider (*Hall and Cockrum, op. cit.*:464, fig. 116).
- Prairie Vole.—From study skins in Museum.
- Pine Vole.—Grossenheider (*Hall and Cockrum, op. cit.*:449).
- Black Rat.—From study skins in Museum.
- Norway Rat.—From study skins in Museum.
- House Mouse.—Modified from Grossenheider (*Burt and Grossenheider, op. cit.*, Pl. 15).
- Meadow Jumping Mouse.—Modified from Orr (*op. cit.*:105).
- Porcupine.—McAllister (*Hall, op. cit.*, p. 102).
- Coyote.—Modified from P. and G. Mattson (*Orr, op. cit.*: 58).
- Red Wolf.—After Weber (*The Wolves of North America*. By S. P. Young and E. A. Goldman. The Amer. Wildlife Inst., Washington, D. C., Pl. 1, 1944).
- Gray Wolf.—From a variety of sources.
- Red Fox.—From acquaintance with the animal in life.
- Swift Fox.—Based mainly on a photo by E. T. Seton.
- Gray Fox.—Adapted from McAllister (*Hall, op. cit.*, p. 88).
- Grizzly Bear.—From a variety of sources.
- Black Bear.—From a variety of sources.
- Raccoon.—After Pray? (*The Mammals of Illinois and Wisconsin*. By C. B. Cory. Field Mus. Nat. Hist., Publ. 153, Zool. Ser., Vol. 11, p. 46, 1912).
- Mink.—Based on a variety of sources.
- Long-tailed Weasel.—After Donald McLean (*Hall, op. cit.*, p. 86).
- Black-footed Ferrett.—From study skins in Museum.
- Badger.—From a variety of sources.
- Striped Skunk.—From study skins in Museum.
- Spotted Skunk.—From specimen No. 39186 KU, ♀, $\frac{3}{4}$ mi. S Hobart, Kiowa Co., Oklahoma.
- River Otter.—From a variety of sources.
- Mountain Lion.—From a variety of sources.
- Bobcat.—From a variety of sources.
- Wapiti.—From a variety of sources.

Black-tailed Deer.—Modified from a photo taken in Yellowstone National Park.

White-tailed Deer.—From a variety of sources.

Prong-horned Antelope.—Mary M. McAllister (Hall, *op. cit.*:106).

Bison.—From a variety of sources.

IDENTIFICATION—USE OF KEYS

Sooner or later, once a specimen has been obtained, the question of its identity arises. What kind is it? What species is it? These are two ways of asking the same question. To answer it the person will need to refer to the keys. The first key to be consulted is the one to orders on page 9.

Suppose we have captured a mammal at the edge of the woods. With it before us we turn to page 9 and read the first entry, "1. Inner (first) toe of hind foot without nail. . . ." etc. Our animal does not possess the described features. So, we direct our attention to the opposing one of this pair of statements, namely, to "1'. Inner (first) toe of hind foot absent, or if present with a nail. . . ." and we see that our animal does possess the described features; but under "1" there is another pair of opposing statements. By choosing the one which "fits" our animal we arrive at 6 and its opposite 6'. Our animal answers to the description of 6 where there is no choice but instead the statement "see key to Order Rodentia on page 77." So, we have ascertained that our animal is a rodent and not, say, a shrew.

On page 77, the Key to the Families of the Rodents is examined in the same way as was the key to the Orders of Mammals and we find that our animal belongs to the Family Sciuridae on page 78. In that key to the nine species of squirrels we end up with a choice, let us suppose, between 4 and 4'. Because the long hair on the side of the tail is tipped with white instead of being all red we suspect that the animal is a Gray Squirrel. To make sure from the key we need to ascertain whether "P3" is present or absent. At this point we may have to turn to the Glossary on page 295 to make certain that we know exactly what "P3" is. By means of the definition in the glossary we learn that "P3" is a tooth in the upper jaw—the fifth tooth counting from the back end of the tooth-row forward. Prying open the mouth and inspecting the teeth reveals that there is a "P3" (= premolar 3) and so we conclude that our animal is a Gray Squirrel. The page number given in the key at the end of the vernacular name, "Gray Squirrel," permits us to read, on page 79, about the animal—its other diagnostic features and habits.

NAMES—VERNACULAR AND ZOOLOGICAL

On the next page, 81, we find two names. The first (upper) name is the vernacular (common) name. It is set in ordinary Roman type. The second (lower) name is the zoological ("scientific") name. It is set in Italic type. Probably the vernacular name will suffice for our purposes. It applies to the entire species including all of the subspecies (a definition of subspecies is given below on page 254).

Should we have occasion, however, to talk with a French Canadian naturalist or a Mexican naturalist about a given kind of mammal the vernacular name would be different in each instance and, therefore, we might need to use the zoological name, say, *Sciurus niger*. It is Latinized and is used by all of the zoologists whether they be French, Spanish or of some other nationality. Another use that the zoological name has is to show the relationships, or groupings according to natural affinities, of the several species. This works out as follows: the zoological name is made up of two parts. The first part is the name of the Genus and the second part is the name of the species. The Fox Squirrel, *Sciurus niger*, and the Gray Squirrel, *Sciurus carolinensis*, have the same generic name, but the Flying Squirrel, *Glaucomys volans*, has a different generic name, *Glaucomys*. Inspection of these three names tells us that the studies of zoologists have led them to conclude that the Gray Squirrel and Fox Squirrel are nearer relatives of each other than either is of the Flying Squirrel. Still another useful feature of zoological names is that there is only one such name for any one kind of animal. The rule is that the first name given, generic and specific, with the beginning date of 1758, shall apply. Also for any one zoological name there is only one kind of animal to which it properly applies. This is not the case with vernacular names, for as we already have noted there may be three different names (French, English and Spanish) for the same animal; also the same vernacular name may be applied to different kinds of animals! For example, Gray Gopher in Montana designates a kind of animal that a Kansan would term a ground squirrel and in Washington the name Gray Gopher denotes a kind of animal that a Kansan would term a pocket gopher.

The discerning reader will note that the zoological name of the Gray Squirrel is written as "Sciurus carolinensis Gmelin" and that the zoological name of the Flying Squirrel is written as "*Glaucomys volans* (Linnaeus)." These forms of the names tell the zoologist

several things. For one thing they tell him that a place to seek additional information about the Gray Squirrel is in the book written by Gmelin. For a second thing, the zoologist who reads that name will know that the zoologist who wrote it was attempting to apply the name *Sciurus carolinensis* to the same kind of mammal as that to which Gmelin applied the name—and not to the kind of animal to which Smith, or Brown, or somebody else in, say, 1800, applied the name *Sciurus carolinensis*; some of those naturalists other than Gmelin may have used the name incorrectly, or, in those days when mail service between different countries was less prompt than now, one zoologist might unknowingly have coined the same name for one kind of animal that had been coined several months or years before by a zoologist in another country for a different kind of animal. The fact that credit is given to Gmelin for naming the Gray Squirrel is another factor but a secondary one. Still other things that the two zoological names at the beginning of this paragraph tell the zoologist are that when Gmelin proposed the specific name *carolinensis* he placed it at that time in the Genus *Sciurus* but that Linnaeus placed the specific name *volans* in some genus other than *Glaucomys*. The absence of parentheses around Gmelin and the presence of parentheses around Linnaeus are the means of imparting this information. Actually, Linnaeus used the name-combination *Mus volans*. Later it was discovered that *volans* did not belong in the Genus *Mus*. Now, no matter in what genus the species *volans* is placed other than *Mus*, the name Linnaeus must remain in parentheses when it follows the specific name *volans* of the Flying Squirrel. The person who uses zoological names should remember that the name has two parts, that the generic (first) part always is written with an initial Capital and that the specific (second) part always is to be written without a capital letter. (Botanical names follow slightly different rules for the specific name.)

As a person becomes more and more familiar with the kinds of mammals he may wish to give attention to the subspecies. Names of subspecies have three parts instead of only two parts. For example, *Sciurus niger rufiventer* is the name of the subspecies of Fox Squirrel that occurs in Kansas. The word subspecies is both singular and plural, just as the word species is both singular and plural. Specie is another word, with a non-zoological meaning, and is not the singular of species. A subspecies of mammal is nothing more or less than a geographical part of a species. When a species is divided into two or more subspecies, the division is made

on the basis of recognizable differential features such as color, size, and shape of some parts of the skull. Each of a few species of mammals, although occurring over a wide expanse of territory, shows no features, consistently, in one area that do not occur in other areas; consequently, no subspecies are recognized. In another species of similar geographic distribution all of the individuals from one large area may possess distinctive features (say, dark color, short tail, and wide skull) not occurring elsewhere in the range of the species. That part of the species will be named as a subspecies.

The names of the subspecies that occur in Kansas are mentioned in small type at the end of the account of each species.

The recognition of subspecies is one method of cataloguing geographic variation, and subspecific names are useful mainly as handles, in technical studies, for dealing with differences in shape or size or color that characterize different populations of a species. Such differences of a geographic nature ordinarily are correlated with long-standing differences in altitude, temperature, soils, or some other feature of the environment.

The distinction between a species and subspecies can be explained in this way: Where the geographic ranges of two species meet or overlap, there is no cross-breeding; every individual animal is unequivocally one species or the other. Where the geographic ranges of two subspecies meet or approach each other, the animals of one field freely cross-breed in nature with those of the next adjacent field and in these populations of intermediate geographic position there is intermediacy of physical structure, or mixing of physical attributes. This intermediacy or mixing, as concerns structural make-up, is spoken of as *intergradation* and the animals themselves are spoken of as *intergrades*. In brief, the criterion of subspecies is intergradation in nature, and the criterion of species is absence of intergradation in nature.

Because subspecies are useful mainly, if not exclusively, to the technical zoologist, he uses the zoological names instead of any vernacular name. There seems to be no sufficient reason, therefore, for us to attempt to coin vernacular ("common") names that are distinctive for subspecies of mammals. Even though serious studies leading to the publication of new information on the habits or on the economic importance of certain mammals is to be undertaken, the name of the species will suffice if the place of observation, or of capture of the mammals, is precisely stated.

USEFUL ANGLES CONNECTED WITH THE STUDY OF MAMMALS

In our time when the complexities of modern living demand specialists in a multitude of fields, the demand for mammalogists tends to exceed the supply.

Although the best reason for studying mammals probably is the desire to satisfy a natural curiosity about them, there are also many practical angles to mammalogy. For example, when certain crops are to be grown in an area, which if any of the native mammals will compete with man in harvesting these crops—that is to say, which mammals are injurious to his crops? Which, if any, are beneficial to him, say, by keeping down the numbers of crop destroying insects? This is the field of economic mammalogy.

Which kinds of mammals, if any, harbor and carry diseases that man contracts—and *vice versa*? On that last point: are one or several of our native mammals better adapted than the Guinea Pig and White Rat to studies of nutrition and disease control? Probably several of them are better adapted. Only recently the Cotton Rat was found to be the best of all for working out cause, course and treatment of influenza!

Much emphasis nowadays is placed on the recreational value of hunting. Which mammals best withstand hunting pressure? Fur-bearing mammals were of great economic importance until a few years ago, and probably will be important again. Which of these is most profitable to raise and exploit—in the wild and in captivity?

In psychological and sociological studies the specialists in those fields have hardly gone beyond the White Rat in their studies that are so very important for the future of man. Certainly much that will be useful to man in managing his own affairs is yet to be learned by study of his varied cousins, the other mammals.

These are but a few of the now obvious relations of mammals and man. He is a selfish creature, admittedly. Therefore he can well afford to know more about the other mammals.

But who can be effective in these needful studies? Several specialists—chemists, statisticians, economists, medical investigators, game specialists, and others—can make their contributions but only if there are mammalogists, that is to say, persons trained to recognize and identify the mammals. Can you supply us with a well-trained mammalogist? We have been asked that question a score of times in the last year. He is wanted for work in the Game Com-

mission, for work in the new rice-growing area of the Philippines, for the research team that is studying animal-borne diseases, for the Bureau of Animal Industry, for the expedition to New Guinea for the staff of the University of A—a, etc. What is needed are persons who can identify closely related kinds of wild mammals—persons who can investigate the habits and even structure (anatomy) of the mammals.

Who should undertake to train themselves to fill some of these needs? As was said at the outset, probably the best qualifications a person can have are an interest in mammals and curiosity about them—a curiosity founded on a real interest in wild mammals for their own sake. Experience shows that the person who imagines himself fortunate to be paid for his work (which he would be doing anyhow to satisfy his natural bent and curiosity) is the one who is most successful. Especially for that kind of mammalogist there is no lack of opportunity just now and in the foreseeable future. So, if you think you were born to be a mammalogist, be one. There is no better way to begin than by collecting some mammals and preparing them as study specimens.

SUGGESTIONS FOR COLLECTING

The basis of the following suggestions is a set of instructions for collecting to which, in 1927, I was invited to make additions when the late Professor Joseph Grinnell was revising the same. As I remember it he told me that the version we then were working on had been somewhat modified by him from a still earlier version drawn up by Dr. Walter P. Taylor and himself. In 1946 Dr. Donald F. Hoffmeister and I rewrote the suggestions and provided them in mimeographed form on paper perforated to fit in the backs of the loose-leaf note-books of the collectors who were working in the field with us. The version that follows includes still other modifications by my associates and myself at the Museum of Natural History of the University of Kansas. I remember contributions from R. H. Baker, H. B. Tordoff, E. H. Taylor, D. F. Farmer, R. R. Camp, F. B. Cross and R. W. Wilson. The parts on modern fishes and fossil vertebrates are, in fact, written mainly by Cross and Wilson, respectively.

Because a collector of mammals usually collects other vertebrates it has seemed appropriate to include in this handbook on Mammals the other suggestions, that we at the Museum normally provide to our collectors, concerning the collecting and preparation of specimens.

In the first place the value of specimens is greatly enhanced by having them in excellent condition, and, of course, they must be accompanied by adequate data. Often a specimen may be well prepared and adequate data for it recorded, but subsequently, through faulty packing, incorrect method of labeling or improper care and protection against pests and climatic condi-

tions, it may be rendered worthless. Proper care at all stages of field work, therefore, is required to insure good quality in specimens. More details than are provided here on the techniques of preparing bird skins and mammal specimens are given in other authors' publications which can profitably be consulted. One of the best publications in this field is R. M. Anderson's "Methods of Collecting and Preserving Vertebrate Animals" (Bulletin No. 69, pages 1-162, illustrated, second edition, National Museum of Canada, March 22, 1944).

WHAT TO COLLECT

In preparing mammals caught, divide your efforts between common and rare species. As a rule, even with the more common species, save a pair from each locality. Series of up to thirty from one locality should be saved in each center of suspected differentiation—these to include young of different ages as well as adults.

With birds, do not use up time on series of well known, and especially migrant species. However, save anything unrecognized, or needed to back up note-determinations.

For reptiles, amphibians and fishes it is difficult to make accurate determinations in the field except of a few larger species. Consequently, it is wise and economical to bring in many individuals and, if necessary, to allow the curator to eliminate unwanted material at the Museum. Snakes (and other kinds of animals) killed on roads, if not too badly mashed, should be taken and preserved at least until they can be replaced with other, better specimens.

Ownership of nests and eggs of birds should be established beyond question before they are taken. Weathered skeletons or skulls of animals found may be desirable as specimens. For these, care must be taken to obtain all bones, and also teeth, as these frequently will have fallen out.

Contents of cheek pouches and samples of feces may be saved dry.

If lice, earwigs, flies, fleas and other ectoparasites are to be preserved, it is desirable to examine not only the vertebrates but also the nests of the vertebrates.

Plants to be saved should be placed in presses as per usual botanical practice. Seeds may be collected dry in any adequate containers.

EQUIPMENT AND PROPRIETIES

Mouse traps of the variety that snap shut on the animal can be purchased in almost every hardware store. These traps are satisfactory for shrews. For mice, however, the larger "Museum Special," manufactured by the Animal Trap Company of Lititz, Pennsylvania, is best because the wire that strikes and kills the mouse is far enough from the treadle to keep the head of the mouse from being struck and crushed. Broken skulls are less desirable than unbroken skulls. The still larger rat trap is stocked in most hardware stores and is suitable for taking animals the size of wood rats and small ground squirrels. Steel traps in sizes 0-4 are used in many areas to secure other animals. McAbee gopher traps are the best yet devised for taking pocket gophers. A variety of mole traps are on the market; the stabbing variety is preferred by most of the collectors that I know.

Many specimens are most effectively taken by shooting. For smaller and medium-sized kinds a shotgun is recommended and furthermore shot of small size should be used in order to avoid unnecessary mutilation of the animal. For many years the double-barreled 16 gauge shotgun has been a favorite of collectors; it is customary to carry a standard 16 gauge shell in the left barrel and a metal bushing in the right barrel. The bushing is drilled to chamber a 32 caliber metal shell loaded with No. 12 shot. The collector is ready to shoot animals of fox- or eagle-size with the charge from the left barrel or mice, chipmunks or small birds with the charge from the right barrel.

Nets of silk, such as are manufactured in Japan, are useful to the mammal collector especially in capturing several kinds of bats.

Metal forceps, 10 to 14 inches long frequently come in handy when bats or other small mammals have to be removed from crevices.

For safely storing prepared specimens in accessible fashion, a museum cabinet that excludes insects, dust and light is essential. A visit to the nearest museum known to maintain a collection of study specimens of mammals, or a letter of inquiry addressed there, will yield all needed information on the type of container best suited to the needs of the collector. Advice concerning the cleaning of skulls can be obtained from the same source.

Every state has its own laws relating to hunting and the collector should obtain and read the laws so as to carry on his collecting in conformance with the law. The State Fish and Game office can provide a copy of the laws and that office, in most states, is the place to apply for a "scientific collecting permit." The collector should also find and inform the local game protector of proposed collecting because this can be of mutual benefit; the collector often receives valuable advice as to where certain species occur locally and the game protector needs to know who is afield in his area and oftentimes obtains information valuable to him from the catches of the collector.

Wherever animals are collected on privately owned lands the permission of the land owner or his tenant must be obtained in advance. Application of the Golden Rule with land owners and the Game Protector will avoid trouble for the collector and bring him welcome assistance.

NOTE TAKING

Field notes can usefully be divided into: (1) catalogue of specimens, (2) itinerary or journal, (3) accounts of species. Enter the name of the collector and the year in the upper left-hand corner of every page, but far enough from the margin to permit binding of the pages. Each page should be filled before another page is started. Use only Higgins Eternal Black Ink. For convenience, all three sections of the notes ordinarily are kept in a single binder, but separate binders may be used.

CATALOGUE

In the catalogue, all specimens of vertebrate animals should be given consecutive numbers. Never repeat a number; for instance, do not begin a new series each year. One line of the notebook page should be devoted to the precise locality. Include distance in air-line miles from some well-established landmark. Include also elevation, county, and state. Devote one line to each

specimen. If not a conventional specimen, indicate the nature by entry directly above the field no., whether (if) skeleton, skull-only, skin-only (not of birds), or alcoholic (not of fishes, amphibians or reptiles). Toward end of line it may be desirable to enter, on occasion, color of iris and soft parts. Use vernacular name of the species if you are not sure of the scientific name.

ER.Hall 1945	Catalogue	
	Horse Creek, 6½ mi. W Meriden, 5200 ft., Laramie Co., Wyo. July 19, 1945	
6103	♂ pocket gopher	235-61-31-6 - wt. 144.9 gm.
6104	♀ "	230-67-30-6 - wt. 117.4 gm.
6105	♀ bat	125-47-11-17-tragus 8, wt. 19.0 gm.
	Horse Creek, 6 mi. W Meriden, 5200 ft., Laramie Co., Wyo. July 20, 1945	
6106	♀ <u>Dipodomys</u>	[252]-[136]-44-14-wt. 90.5 gm.
6107	♀ "	265-152-43-14-wt. 79.3 gm.
6108	♂ <u>Onychomys</u>	122-31-20.5-16.5-wt. 22.7 gm.
6109	♂ "	122-35-20.5-18-wt. 22.7 gm.
6110	♀ mouse	160-73-20-17-wt. 22.7 gm.
6111	♀ <u>Peromyscus maniculatus</u>	143-53-20-15-wt. 16.5 gm.
6112	♀ <u>Neotoma</u> <small>crassirostris only; pick up by Setzer</small>	300-125-37.5-26-wt. 174 gm.
6113	? <u>Sylvilagus</u>	
	Horse Creek, 3 mi. W Meriden, 5000 ft., Laramie Co., Wyo.	
6114	♀ <u>Sylvilagus nuttallii</u> Coll. by H.W. Setzer	445-33-97-52 - ^{crown} wt. 176.3 gm.
		$\frac{3}{2}$ mi. W La Grange, 4600 ft., Goshen Co., Wyo.
		July 21, 1945
6115	♀ <u>Sylvilagus</u> Coll. by H.W. Setzer	408-40-93-54 - ^{crown} wt. 136/gms.
	Horse Creek, 6 mi. W Meriden, 5200 ft., Laramie Co., Wyo.	
6116	♂ <u>Dipodomys</u>	246-156-43-14-wt. 75.8 gm.
6117	♂	249-141-39-14-wt. 63.8 gm.
6118	♂	273-159-44-14-wt. 75.0 gm.
6119	♂	264-151-43-16-wt. 77.9 gm.
6120	♂	259-149-42-14-wt. 69.9 gm.
6121	♂	254-145-41-15-wt. 69.4 gm.
6122	♀	254-143-42-14-wt. 80.1 gm.
6123	♂	[252]-[143]-42-14-wt. 67.7 gm.
6124	♂	278-164-44-14-wt. 69.5 gm.

FIG. 75. A page from the author's field catalogue, slightly less than three-fifths natural size. Blue horizontal lines fail to show in this photograph.

ITINERARY

E.R. Hall
1945

Itinerary

- July 17 (continued) possibly by sheep although I have not yet seen any.
- July 18. Glenys, 5300 ft., Laramie Co., Wyo. - After we unloaded at the schoolhouse, I drove back 40 miles, to Cheyenne, to have auto-repair made. A new battery, new cables and adjustment of the cut-out switch were required - cost \$21.28. Returned to camp at 1:30 P.M. In late P.M. drove 8 miles W along creek, which in most places is grazed right down to the edge and is not lined with brush or trees and therefore not suitable for short-eared cottontails. Saw prairie dog 7 mi. W of our camp. Set 83 traps (mouse) 15 + 20 paces apart $5\frac{1}{2}$ mi. S of camp, in scattered Spanish bayonet with sparse growth of grass between the bayonet-plants.
- July 19. Took 2 Perognathus hispidus, 2 Onychomys, 1 Peromyscus & 1 Dipodomys - nothing more! - and only 6 traps sprung, namely those containing the 6 animals. Set 100 traps along the N side of the road leading south from camp, and ^{100 traps} 1 mi. S of Horse Creek (Horse Creek, $6\frac{1}{2}$ mi. W Meriden, 5200 ft., Laramie Co., Wyo.). These were set uniformly 15 paces apart, in grass with occasional Spanish bayonet.
- July 20. Took 2 Dipodomys and 2 Onychomys in traps. In evening with Hubert, Leonard and Setzer, hunted cottontails 3 mi. W Meriden, along Horse Creek. I got one yg. short-eared cottontail. Setzer got one adult short-eared cottontail and 1 yg. long-eared cottontail. Set no traps - left 11 rat traps set at two ledges.

FIG. 76. A page from the author's field note book, slightly less than three-fifths natural size. Blue horizontal lines fail to show in this photograph.

On the first line of the itinerary enter date and locality. Follow with a concise account of route and travel area and habitats studied, and record number and kinds of traps set, distance between traps, number of vertebrates collected, as well as other pertinent information. For example, record num-

ber of traps set in each type of vegetation and numbers and kinds of animals caught therein. Section, township and range comprise useful information.

ACCOUNTS OF SPECIES

Accounts of species should be headed either with the scientific or common name, as preferred. The date and locality for the account should be given on the first line. Only one species should be written about on a single

		Species-account
ER Hall 1945		<u>Sylvilagus audubonii</u>
July	12.	11 mi. N + $5\frac{1}{2}$ mi. E Cheyenne, 5950 ft., Laramie Co., Wyo. At the Pole Creek Farm (on U.S. 8 & 8 topo map), with buildings now unoccupied, we (Setzer) shot 6 rabbits - 2 ad. + yg. of various ages. This was at about 8 Q.M. When frightened from their feeding, the rabbits ran to the shelter of the sheds, piles of troughs, and floors of bldgs. This was on the upland - $\frac{1}{2}$ mi. or more from Pole Creek, which has short sparse willow growth only in clumps at this place.
July	13.	$\frac{1}{2}$ mi. E Horse Creek P.O., 6500 ft., Laramie Co., Wyo. One yg. (6077 of E.R.H.) was shot at the Smith Ranch, at 4:30 P.M., as the rabbit dashed from closely grazed pasture to the shelter of a post-pile.
July	15.	3 mi. E Horse Creek, at Whittaker Ranch, 6400 ft., Laramie Co., Wyo. Hubert shot an adult which he earlier learned hid for safety under the house there that was deserted.
July	18.	$6\frac{1}{2}$ mi. SW Meriden, 5200 ft., Laramie Co., Wyo. Two taken here as we drove to our camp. Skulls and measurements were saved. Each was a nursing female.
July	21.	Yesterday Setzer shot a young animal on the gravelly hill above Horse Creek (south of it) about $\frac{1}{2}$ mi. from where I shot a young short-eared cottontail. Today the sheep-herder brought us another long-eared young animal of about the same size; think we shall not prepare it as a specimen.
July	24.	Kinney Ranch, 6800 ft., 21 mi. S Bitter Creek, Sweetwater Co., Wyo. Hubert Hall saved skull of one and Ben shot another.

FIG. 77. A page from the author's field note book, slightly less than three-fifths natural size. Blue horizontal lines fail to show in this photograph.

page. Information in the account should not be a repetition of material given in the itinerary or journal. Include not only facts but make interpretations and generalizations. The accounts should be written in a style suitable for quoting in any publication. Accounts of species need not be restricted to kinds collected. If the account is about animals collected, it is wise to refer to the animals by your field numbers.

Head each and every notebook page with collector's name and year, page number (if number system is used), locality (in *detail* the first time used), and date.

Write *full* notes, even at risk of entering much information of seemingly little value. One cannot anticipate the needs of the future, when notes and collections are worked up. The following are suggested topics, but do not restrict yourself to these alone. Be alert for new ideas and new facts.

Describe vegetation (saving plant-press samples of species not positively known), nature of ground, slope exposure, and drainage in each belt of animal life sampled. Describe exact location of trap lines, referring to your topographic maps, and also enter a sketch, in profile, or surface view, or both, to illustrate the location and relations of the different habitats crossed. Properly marked maps for each region worked should ultimately be bound in with the field notes, of at least one member of your field party.

Keep record of closeness of settings of traps, distance covered, and results of each night's trappings; give number and type of traps put out in each habitat and number of animals of each species captured in each habitat (whether or not preserved). In some instances it is advisable to record the sex, age, and breeding condition of each animal.

Keep full record of breeding data: Number and approximate size (length) of embryos, or of young found in nests; state of incubation in eggs. Dig out burrows if practicable; make drawings to scale, plan and elevation; describe fully.

Record food plants; keep specimens for identification where not known by a definite name; preserve contents of cheek pouches, contents of gullets, stomachs of mammals and large birds. If these are not saved, identify and record contents.

Note regularly in notebook all "pick-ups," that is, odd skulls or fragments of animals of whatever sort or source, serially numbered along with specimens of the more usual sort. Give full information, as with odd skulls secured from trappers. Label all such specimens adequately, as elsewhere described.

Keep frequent censuses of diurnal birds and mammals, with habitat preferences indicated. These censuses, if short, need not be entered on formal census sheets. When leaving a well-worked locality, enter a summary of species observed, with remarks of a general nature, such as relate to local conditions of terrain, human activities, and other pertinent conditions.

Where feasible, interview old residents, trappers, National Forest and National Park rangers in each locality visited. Always record accurately the name, official position or occupation, and address of each person giving information; give also your opinion as to his reliability. Note general attitude of persons interviewed as to game laws, conservation and effects of settlement by Man and record specific comments, complaints or criticisms.

Ascertain present numbers and distribution of large mammals and birds as compared with former status. So far as is possible get definite statements expressing ratio of abundance now, compared with a definite number of years back. Seek such information, where feasible, by indirect query. Do not risk influencing your informant's statements by leading questions. Record fully all evidence as to human influence upon original or "natural" balance. Record present economic relations of vertebrate animal life, that is, effect on agriculture and stock raising, with full details. Note opinions of persons interviewed as to whether species should be protected or destroyed. Describe local methods of capture or destruction; give your opinion as to their effectiveness and justification.

Opportunity offering, record detailed observations on effects upon vertebrate animals of: severe storms; floods; forest, brush or prairie fires; overgrazing; tree cutting; road-building; or tree-planting.

LABELING OF SPECIMENS

Use one serial set of field numbers for *all* specimens (including "pick-ups," nests and eggs, wet preservations, and ectoparasites).

Of course every specimen is to be fully labeled at the time it is prepared—and before the preparation of another is begun. A complete, authentic label for a mammal in most instances is scientifically more valuable than the skin to which it is attached. Beginners may not realize the prejudice engendered in careful zoologists by sight of a specimen incompletely labeled or of a specimen with a complete label unattached or insecurely attached to the specimen.

For each specimen always give altitude and county as well as exact place; for example: "3 mi. NE Lone Star, 850 ft., Douglas Co., Kans." Attend minutely to proper punctuation. If not true NE, give miles north and miles east. Distances always to be air-line. Locality data to be given in notebook precisely as on specimen label.

Record data on labels for skins on one side only (the opposite side is left blank for entering the name in eternal ink after laboratory studies have been completed). Enter data on 3 or 4 lines as may be necessary, and in the order indicated below.

On the first (top) line record sex (if female, record number and size of embryos or absence of embryos), collector's field number, and collector's name. Record immediately following the field number the name of the person to whom the number pertains and preface the name of the second person with "Coll. by" or with "Prep. by" for the purpose of insuring that the field number will be associated only with the name to which it pertains and also to show which person was the collector and which one was the preparator. This information is important and especially so when necessity arises for tracing back through the field notes (catalogue, species account, or itinerary) to obtain supplementary information.

On the second line, or on the second and third lines, record the locality exactly as in the catalogue and other parts of the field notes—even to punctuation and abbreviation.

On the last line, record total length, length of tail, length of hind foot, height of ear from notch, weight in grams, and date. Use dashes (not commas, periods, colons or semicolons) to separate the measurements. Use the

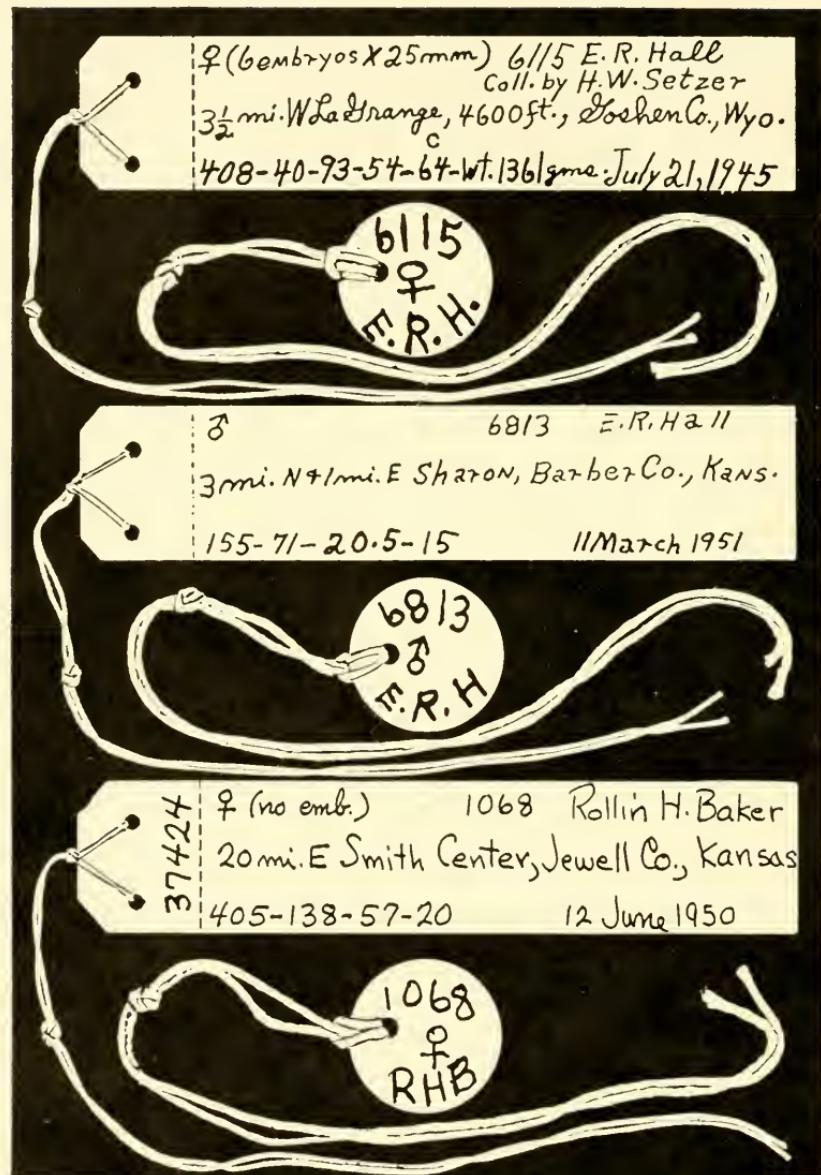


FIG. 78. Labels, fully filled out. The larger labels are for stuffed skins; the smaller labels are for uncleared skulls. Actual size.

abbreviation "gms." after the weight to show that the weight is recorded in grams instead of in grains or in ounces. Write out the names of months

that are no longer than 5 letters; abbreviate the names of the others. Never use a numeral to represent the month because doing so increases the chances of error in later transcriptions of the month and day. For example, depending on the country from which a person comes, the date June 9, 1953, is written in at least the following forms: VI-9-1953, 6-IX-1953, 6-9-1953, VI-IX-1953, 9-6-1953; still other combinations are possible and may be used; even within different parts of one country (The United States of America) the form varies. Any one of the above combinations of numerals means Sept. 6, 1953, to some persons and June 9, 1953, to other persons; consequently it should be written "June 9, 1953" or "9 June 1953" in order to avoid error. Also use four numerals for the year (1953) and not an apostrophe and two numerals ('53) because the apostrophe can waste valuable time of the zoologist in ascertaining whether 1753, 1853, or 1953 is correct.

On a skull-tag, enter field number, initials and sex symbol with Higgins Eternal Ink; write '*large* and *heavy*,' to prevent fading of the number, and consequent loss of a specimen.

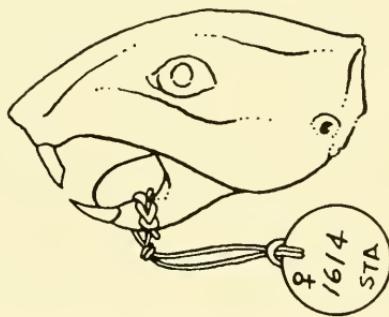


FIG. 79. Skull-label correctly tied to one ramus of the lower jaw of a skull freshly skinned out, and immediately before immersion in water.
X 3/4.

Attach tag to skull by running the string between the *lower jaws*. Tie with about $\frac{1}{4}$ " slack in the string. Do not tie tightly around the lower jaw; there is danger of breaking it in skulls of bats or shrews. Also, a loose string allows the larval dermestids to eat the meat directly between the string and jaw bone. Cut off the loose ends of the string.

All miscellaneous material should bear labels with notebook references by specimen numbers, and initials of collector. Nests should be "threaded" and have labels attached to them (not only to container). Folders for plants should each be inscribed with full data, as per usual botanical practice. Eggs should have labels placed *within* containers in small envelopes or boxes, and such containers should be packed in a stout box to prevent crushing.

LABELS

Labels for skins—Paper used as labels should last for centuries, take ink well, hold ink well even when labels are immersed in liquids, and retain its strength in water or formalin or alcohol. At the Museum of Natural History of the University of Kansas we use, as best meeting the requirements mentioned above, "Resistall Index, Bristol 100 per cent rag". This paper has a weight of 110 lbs. From sheets 25- $\frac{1}{2}$ x 30- $\frac{1}{2}$ inches we cut out the labels, after printing, that are to be attached to skins.

Stacks of 50 labels are firmly held in a metal frame of appropriate size, two holes are drilled, by means of a bit in a drill press, near one end of the stack of labels. See figure 78 for exact position of the two holes.

For threading the labels we use Star Brand, white, 6-strand, mercerized, size 10, cotton thread manufactured by the American Thread Company. This thread comes in spools of 150 yards to the spool. For stringing one label a piece of thread 330 millimeters long is used. After the thread is strung through the two holes in the label, the loose ends of the thread are strung through a half-turn loop taken in the thread of the "back side" of the label. The threads are pulled taut and a knot is tied in the two threads exactly one inch from the end of the label. This label and thread are recommended as satisfactory in all respects save one. The size of our label, in my opinion is too large (see figure 78). A width of 15 mm. and a length of 70 mm. would suffice. Predecessors established the size now used at the University of Kansas and we continue to use it because the advantages of uniformity within a single collection outweigh the advantages that would be gained by changing to another size.

Threading of the labels is done by hand. A smooth flat board, say, 4 x 8 inches, with the point of a finishing nail showing on one side at a distance of one inch from an ink mark facilitates tying the knot at the correct distance from the edge of the label. A skillful person can thread and tie 200 to 300 labels per hour.

Labels for skulls and skeletons are of a diameter (19 mm.) that fits loosely in the bottom of the smaller of the two sizes of glass vials used for housing skulls. These round labels are "Fiber Water Proof Stock, 10 pt." purchased from the Dennison Manufacturing Company of St. Louis, Missouri. The labels are perforated at one side and are strung with no. 5 linen twine, in which a knot is tied exactly one inch from edge of label (see figures 78 and 79). If pressure is exerted when writing on these labels, the writing will be retained even though the labels are immersed in water, ammonia or alcohol. This fiber stock yields labels that are resistant to dermestid beetles and their larvae— insects used to remove flesh from the osteological specimens to which these round labels are attached. Some other kinds of paper are eaten by dermestids if the paper becomes stained with blood.

Notebook paper that is high in rag content is used because its lasting qualities are thought to be superior to most other kinds of paper. Field notes containing observations written "on the spot" of behavior of animals, and census counts of animals under natural conditions in areas that later are greatly modified by man, have increasing value with the passage of time. Such records, therefore, should be on paper that will not deteriorate with age.

SKINNING AND STUFFING SMALL MAMMALS

Tools and supplies normally used are as follows:

Labels for skins

Labels for skulls

Higgins Eternal Ink (not Higgins Drawing Ink or Higgins India Ink)

Dip pen or fountain pen in which Higgins Eternal Ink can be used

30 centimeter rule graduated in millimeters

Sewing needles

White (not colored) cotton thread, 2 sizes

Pliers with clean-cutting jaws and wire-gripping ends on jaws

Forceps with fine sharp points but having arms strong enough to permit of gripping solidly

Scalpel or razor-sharp knife blade

Carborundum sharpening stone

Scissors, surgical type with two sharp points

Cotton, long-fibered, resilient, in smooth bats

Arsenical powder or soap in wide-mouthed container

One shallow pie tin

White cornmeal or fine hardwood sawdust

Other supplies and equipment are optional and may include scraper for removing fat and a 3-cornered file for working metal.

Measure the animal in millimeters and weigh it in grams. Experienced preparators take two measurements, write them on the label, take two more measurements, write them on the label, weigh the animal and write the weight on the label.

The standard measurements for a study specimen are taken as follows:

Total length: Manipulate animal so that it lies out straight (do not stretch it) and measure distance from tip of nose-pad to tip of fleshy part of tail, excluding hairs that project beyond tip.

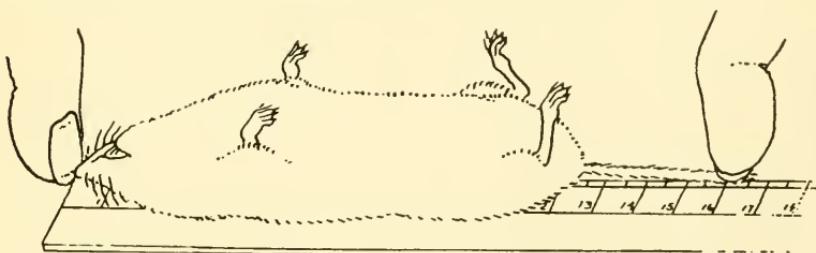


FIG. 80. Measuring total length of a small mammal, $\times \frac{1}{2}$.

Length of tail: Bend tail up at right-angle with body and measure from bend on back to tip of fleshy part of tail, excluding hairs that project beyond tip.

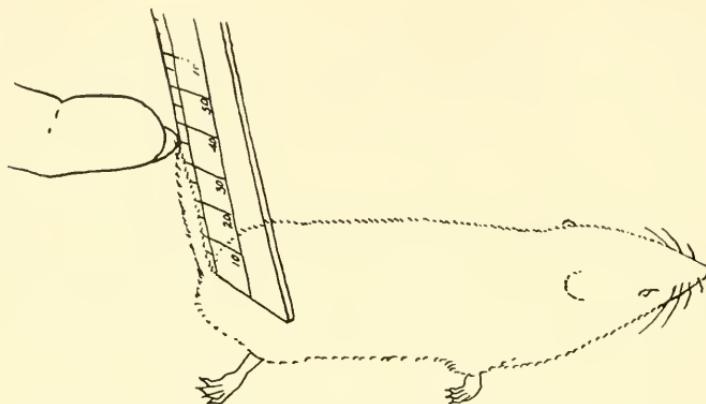


FIG. 81. Measuring length of tail of a small mammal, $\times \frac{1}{2}$.

Length of hind foot: With toes out straight measure distance from tip of longest claw to heel—in same way that over-all length of a person's foot would be measured. Outside of North America the claw is excluded from the measurement of the length of the hind foot and only the fleshy part of the

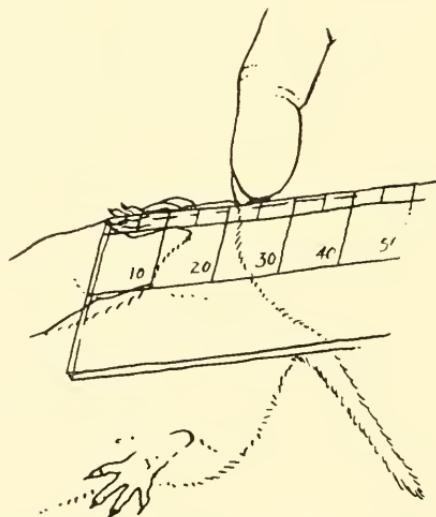


FIG. 82. Measuring length of hind foot of a small mammal by means of a transparent (plastic) rule, $\times \frac{3}{4}$.

foot is measured in mammals from continents other than North America (Greenland, Panamá and Central America are parts of North America).

Height of ear from notch: Insert end of rule in notch at bottom of ear and measure to distalmost border of fleshy part of ear.

Next make out the labels (for skin and skull) and then make the entry in the field catalogue. It may be necessary to enter the sex (and certainly number and size of embryos if any) after the animal is skinned.

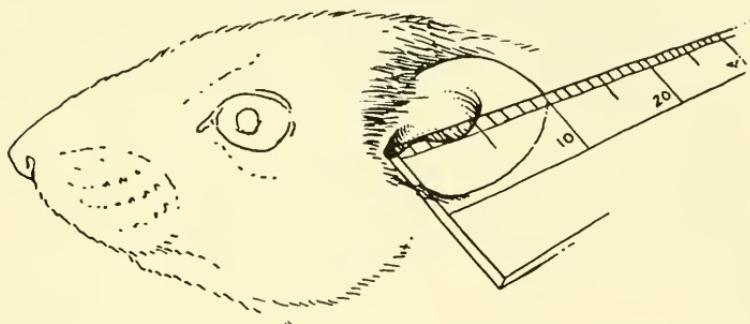


FIG. 83. Measuring height of ear from notch in a small mammal, $\times 2$.

Fold a square piece of cotton or other stuffing to desired size and shape, and lay it to one side. A body too large or too small will cause trouble. A body wider than high and wider at the middle than at either end, to begin with, gives best results. Make the body a fourth longer than the body of the animal (the extra fourth will be cut off later). The back and sides of the body should be smooth; small irregularities in the body make larger-appearing irregularities in the dried specimen. The outside edge of the cotton should be feathered; that is to say, enough of the fiber should be removed to make the cotton taper to a thin edge. When the last fold is made drag the body across the skinning board or table top so as to cause the thin edge of the cotton to adhere to the previous layer. So doing will prevent the body from unrolling while the skin is being turned over it; partial unrolling twists the skin resulting in an unsightly skin. The aim, whatever method is adopted for forming the body, is to obtain a symmetrical, firm yet resilient, body that will retain its shape while the skin is drying.

After the body is made, select monel metal wire of appropriate gauge; with pliers holding one end of the wire stretch a piece until it is perfectly straight. Cut and lay to one side five pieces, one piece for the tail and four pieces for the four legs. A leg-wire should be as long as the bony structure of the limb; wires for the two hind legs should be longer than those for the front legs. The tail-wire should be a half longer than the tail. For pocket gophers and wood rats use No. 20 wire; for a larger *Peromyscus* use No. 22; for small pocket mice use No. 24; for tails of the smallest bats use No. 24 or even No. 26 wire. Monel metal wire, or annealed tin wire, is to be used. Do not substitute other kinds of wire (not even copper, brass or galvanized wire) because those eventually corrode or rust and destroy the specimen. If the correct kind of wire is not available use split bamboo instead, and in any event use bamboo or other straight-grained, tough wood in place of wire in the legs of mammals larger than wood rats. Striped skunks and other mam-

mals of equal and smaller size are to be stuffed; badgers, foxes and larger animals are skinned so that the hides can be properly tanned and preserved unstuffed.

Have ruler, threaded needle, scalpel, forceps, scissors, arsenic container, and pie tin containing a double hand-full of sawdust or cornmeal before you on a table or on a flat skinning board supported on the arms of a camp chair.

With the mammal held, back down, on the sawdust in the pie tin, use the scissors to cut the skin, and if possible not the body wall, on the midline of the belly from immediately in front of the anal opening forward one fourth

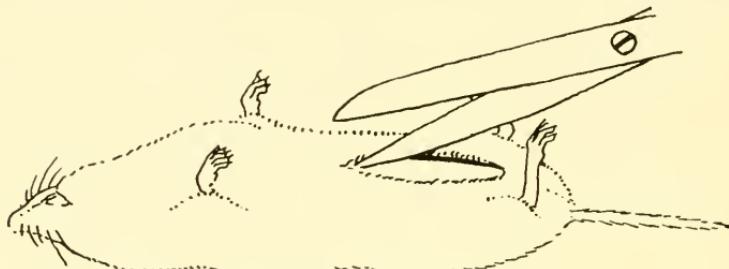


FIG. 84. Making initial incision in skinning a small mammal, $\times \frac{3}{4}$.

of the distance (no more) toward the chest. Experience will enable you to make this cut by means of no more than two snips of the scissors, and to cut only the skin and not the body wall. Retain the scissors on the thumb and finger of one hand while proceeding so as not to waste time in laying down and picking up the instrument each time that it is needed.

With the free hand sweep sawdust onto the cut area. With the third and fourth fingers of the hand holding the mammal, thrust the knee toward the midline of the body, meantime pushing the skin of the belly and flank away from the midline by means of the thumb of the same hand. Grasp the exposed knee with the scissors-hand, and with the forefinger and thumb of the other hand separate the leg from the shin and push the skin all of the way down to the ankle. Insert a blade of the scissors at the ankle in such a way that the bones of the lower leg are between the blades of the scissors, and in one

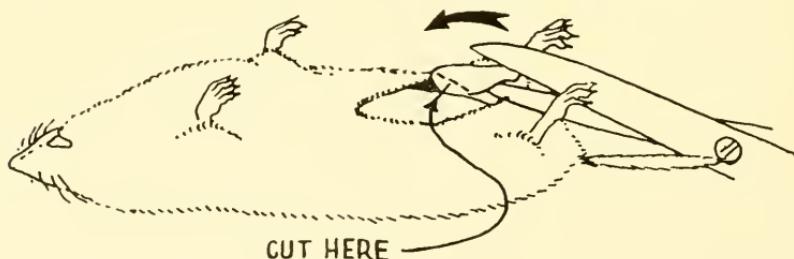


FIG. 85. $\times \frac{3}{4}$. [skinning out hind leg]

motion by means of the blades of the scissors strip the flesh from the lower leg and free the lower leg by cutting it immediately below the knee joint. Repeat the process on the other hind leg.

One reason for leaving the bones of the lower leg attached to the skin, instead of severing the hind leg by cutting through the ankle, is to meet the need that sometimes arises to measure the length of the dry hind foot. If the bones of the lower leg are present, the heel can quickly and certainly be located. If the bones of the lower leg are not present, there will be uncertainty concerning the heel: was it cut away with the bones of the lower leg? If the heel is located, is all of it present? To answer such a question, it is necessary to relax the skin of the hind foot, cut the skin, and visually inspect the bones. These time-consuming operations can be avoided by leaving the bones of the leg in the skin.

Meanwhile, and throughout the whole of the skinning, keep the specimen buried as much as possible in sawdust because the sawdust absorbs fat and any other body fluids, thus preventing them from getting on the fur or on the hands of the preparator. If the fat gets on the hands of the preparator it will be transferred to the fur. Fat on the fur makes the pelage unsightly and spreads eventually to the label and other specimens; fat anywhere on the preparation oxidizes and in time destroys the skin. To keep the specimen immersed in sawdust (or white corn meal) requires that the preparator learn to work as much as possible by touch instead of by sight. Beginners seldom use enough sawdust. The thought that "if some is good more is better" really applies to the use of sawdust in skinning mammals. After eight to ten small mammals that are exceptionally fat are skinned in a small quantity of sawdust it becomes saturated with grease. Discard it and use fresh sawdust.

When the two hind legs have been freed and skinned out in the manner described above, separate the skin from the body wall by working a finger, or handle of a scalpel, between the skin and the body. With the fingernails sever the gut and associated connections of the skin to the body. Scissors or scalpel can be used but time is saved by using the fingernails. When the skin is free all around the base of the tail place three fingernails behind the skin and push it off the tail. One motion will do the job. Take care to keep the nails against the tail vertebrae and behind the skin so as to avoid the misfortune of having the skin of the tail turn inside out; this misfortune slows down even the experienced preparator and is one that may be insurmountable for the beginner.

When the skin is free from the tail and hind legs, separate the skin from the body wall at the anterior end of the initial incision that was made on the belly. Then turn the skin down all around the body and push (don't pull) it off the body. Be sure that the skin is reflected (turned down) on the belly as well as elsewhere; otherwise the skin will gradually tear forward from the front end of the initial incision on the belly as you proceed with the skinning and that misfortune causes the skin to fit improperly on the cotton body with the result that the dried skin of the specimen will be mis-shapen. Push the skin down until the mammal's elbows are in sight. Tear or cut the thin skin-muscle that shows up. Push the skin down to the wrist. Straddle the forearm near the wrist with the blades of the scissors; in bringing the blades of the scissors up from the wrist almost to the elbow strip the flesh from the lower leg and cut the bones immediately below the elbow joint. Do the same with the other foreleg. Drop the scissors because you will not need them again in skinning this mammal. Push the skin farther until the bases of the ears come into view. By means of the fingernails securely grasp the ear tube on two sides

where it emerges from the bone and pull the tube free. When the two ears are free push the skin forward until the eyes are reached. Pick up the scalpel or knife and make two cuts on each eye: one cut straight down across the eye to sever most of the attachments of the skin to the skull, and a second cut on a transverse plane, with the blade of the scalpel against the bone so as to sever the lower (front) angle of the eye from the skull. Care has to be used in making the last cut or the lids at the angle of the eye will be cut with the result that the eye opening will be unnaturally large in the stuffed skin.

Push the skin to the tip of the lower jaws; sever the skin of each cheek and then separate the skin from the front of the jaw by means of three slices of the scalpel or by means of three tears made with the fingernails. By means of the thumbnail push the skin on each side of the rostrum (forepart of the skull) to the tip of the nose. Cut the skin free by a stroke of the scalpel, taking care to cut well ahead of the tips of the nasal bones. Beginners often cut off the ends of the nasal bones, and are especially apt to do this if scissors are used instead of a scalpel.

With experience, less than a minute should be required to skin a mouse; that is to say, no more than a minute need elapse from the instant when the first incision (cut) is made on the venter until the skin is freed from the tip of the nose.

Note the sex. If female note absence or presence of embryos. If embryos are present note number and length from crown to rump. Complete entries on labels and in catalogue. Attach the skull-label to the skull and drop it in water.

With scalpel in hand go over the skin, laid flat on the sawdust, to remove any fat. Remove it all. Fascia or small bits of red muscle are not worth removing. Grasp threaded needle; sew up mouth with a triangular stitch and secure with a knot to prevent the stitch from coming loose. Cut the thread

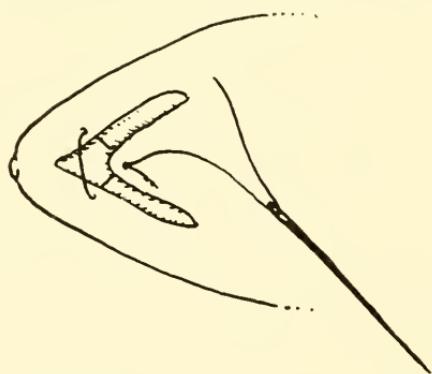


FIG. 86. $\times 1$. [sewing of lips]

above the knot. Tie a knot with one hand at the end of the thread and place threaded needle where you will reach for it the next time it is needed. To all parts of the flesh-side of the skin now apply arsenical soap by means of a brush or apply powdered arsenic by means of a wad of cotton held in forceps.

In each foreleg thrust a wire along the bone of the foreleg into the palm and to the base of the nail of the middle finger without perforating the skin. Begin at the wrist with a thin wisp of cotton and wrap the bone of the lower leg and wire firmly together. Moistened fingers will secure the cotton at the upper end of the wrapping. The foreleg shaped from cotton should be smaller than the original foreleg.

With the forceps pick up a cotton body. Place the outer seam down. By means of the closed forceps press down on the center of one end of the roll of cotton; with a finger and the thumb of the free hand press inward each side of the cotton at the same end; maintain pressure of the thumb and finger on the two sides of the end of the body; transfer the forceps, now opened, to the outside of the finger and thumb, and by means of the forceps constrict the cotton. Repetition of the maneuver forms a firm, sharp-pointed, symmetrical end, pointed downward. Holding this pointed end by means of the forceps, place the nose-pad of the skin (still flesh-side out) against the pointed end of

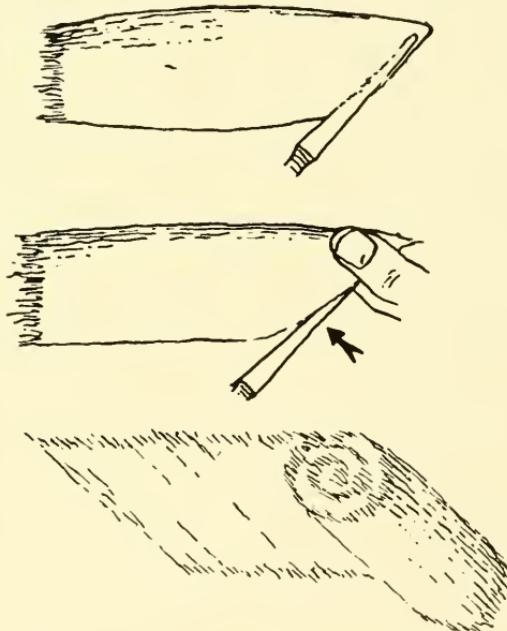


FIG. 87. Folding cotton to make a body, and shaping the end of the body by means of forceps and thumb and forefinger so that the body will fit properly in the nose of the skin,
 $\times \frac{1}{3}$.

the cotton body; turn the skin over the cotton body as far as the forelegs, meanwhile maintaining the grip with the forceps on the pointed end of the cotton; set in place the skin of the head and neck by tugging (not strongly enough to tear it) at the skin in the area of each eye, the skin of the throat, the skin around each ear, and the skin of the breast making certain that the

hard pointed nose of cotton is all of the way to the tip of the nose, that the two eye-openings are symmetrically set, that the ears are exactly opposite each other, and that the skin of the head is fully stuffed. Then release the grip of the forceps. If the head end of the cotton body was correctly formed the cotton will expand, and thus fill out the skin of the head and cause it to be bilaterally symmetrical.

Handling the body and skin as little as possible, turn the remaining part of the skin over the body which should be slightly longer than the natural body. With scissors cut off the surplus end of the body but leave a thin extension on the back (top) side. See that the cut is exactly vertical and exactly transverse. Let the thin extension of cotton from the back cover the cut end.

Rotate each hind foot one-half turn outward. Then wire each hind leg in the fashion described above for the forelegs. Pull the hind feet out behind. The soles should be down. The skin of the hind leg should be stuffed so that the circumference of the lower leg and thigh is the same as it was in life. The wrapping that binds the wire and bone of the lower leg together should be long enough and frayed enough at the upper (proximal) end to make a gradual blend with the cotton body.

Pick up the tail-wire, moisten one end, twirl (by rotating the wire) on a thin strand of cotton, continue twirling so as to wrap a strand of cotton of gradually increasing diameter on the wire. The tail on the skinned body is a pattern for size. Remember that projecting ends of fibers cause the artificial tail to be functionally larger than it appears to be. Consequently the wrapped tail-wire should seem to be of a slightly lesser diameter than the actual tail that has been slipped out of its skin. If the cotton is firmly anchored at each end of the tail-wire and if the diameter is exactly correct, all will go nicely. Hang the unstuffed tail down over the near edge of the skinning board (or table), dust some arsenic on the artificial tail, place the tip of the tail-wire into the open base of the tail, then in one continuous movement thrust the tail-wire all the way to the tip of the skin of the tail—almost to the tip is not sufficient because any unstuffed part will wither and be broken off.

With wire cutters snip off only as much of the free end of the wire as can not be gotten through the slit in the skin of the belly. The wire should lie on the midline of the underside of the cotton body between it and the skin.

Adjust the four legs so that the pairs are symmetrically placed and so that the leg-wires lie parallel to the midline and as close to it as tension on the skin will permit. See that the tail-wire is lined up properly—parallel with the leg-wires and on the midline of the belly midway between the wires of the two hind legs. All of this should be done without picking up the stuffed skin;

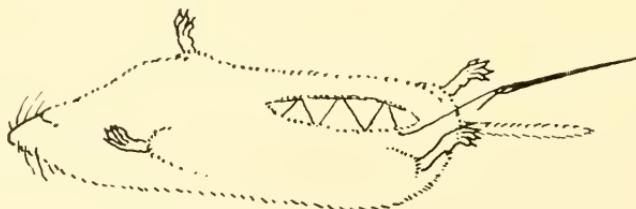


FIG. 88. Sewing a stuffed skin, $\times \frac{1}{2}$.

unnecessary handling at this stage makes the body mis-shapen. Next sew up the slit in the belly. This is to be done by first catching the very edge of the cut edge of the skin with the needle; three or four diagonal cross stiches should suffice. After the last one is taken, pull the whole lot tight; throw a loop in the thread and by means of the points (closed) of the scissors run the loop down to the fur side of the skin to form a knot that prevents the stiches from pulling out as the skin dries. Cut the thread close, say, 2 millimeters, above the knot. Before returning the needle to the place selected for it, tie a knot in the thread so that it will be ready for instant use to sew together the lips of the next specimen that will be stuffed.

Lay the stuffed skin belly-down with hind feet projecting over the near edge of the skinning board. Tie on the label above right heel; take double turn (on the thread, not the leg), pull the thread almost as tight as possible without breaking it, complete as a square knot or tie four alternate granny knots. Cut off the loose ends of the string. The aims are first to tie the knot so snugly that it will not slip off after the diameter of the heel and foot has decreased owing to drying out, and second to tie the knot so securely that it will have to be cut to remove the label.

Use a tooth brush having soft bristles to comb the pelage.

Select 8 glass-headed pins no longer than the depth of the drying tray. Pin down the skin in the form shown in figure 89. Pin down the forefeet first,

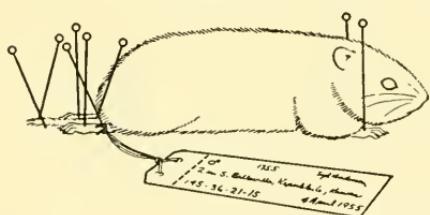


FIG. 89. $\times \frac{1}{2}$.

tail. Line up the tip of the nose, base of the tail and tip of the tail; then pin down the tip by means of two crossed pins. Finally pin down the two hind feet. Inspect the stuffed animal from the rear to see that the two hind feet are equidistant from the tail, inspect from the front to see that the two forefeet are equidistant from the nose, and inspect from each side to see that the tips of the toes of each pair of feet are correctly arranged in anterior to posterior position.

By means of a pair of forceps, or by means of a thumb and forefinger, compress each external ear so that the two ears will be creased exactly alike. This helps in causing them to lie down flat as they dry and if the treatment is repeated on the following day the ears are more likely to be symmetrical when thoroughly dry.

Use a metal pin, the back of a scalpel, or the sharp edge of forceps to smooth the pelage. Set the tray where the skin can dry in a shady, airy place safe from animals and storms. Two days to two weeks later, whenever the skin is thoroughly dry, it can be unpinned. The amount of humidity has most to do with the time required for drying; in a hot dry desert, rodent skins may dry in 24 hours but in a humid, hot, tropical setting the skins may never dry unless artificial heat is used to drive out the moisture.

seeing that each foot has the palm flat down on the board. The forefeet should be underneath the head well toward the mid-line of the body. Slant the pins outward so that they will not crease the skin or fur of the sides of the head. Next pin down the base of the tail by crossing two pins over it, in the fur at its base instead of over the bare part of the

With practice the average preparator can complete a specimen in 12 to 15 minutes. The most rapid preparator that I know did the job in slightly less than five minutes. He, however, could not maintain that pace and actually turned out approximately eight specimens per hour. Self analysis reveals to the beginner that he is making unnecessary movements. Attention to the elimination of superfluous movements probably is the best method of increasing the speed of preparation.

Many persons have suggested means of saving the skins of small mammals without stuffing them, or means of partly stuffing them, as for example with only a piece of flat cardboard. Such skins are less useful for studying geographic variation and speciation than those prepared by the method described above because such studies require comparisons of the new specimens with old specimens—specimens prepared in earlier years. Satisfactory comparisons are made only with specimens prepared in the same form. Since nearly all of the specimens from the past were prepared according to the method described above, specimens to be saved now are most useful if they also are prepared as described above.

An exception of a sort is made for rabbits in that the artificial bodies are prepared in a fashion different than that described above. The approved method is the following: Cut a piece of corrugated cardboard for the center of the body; attach a straight stick to the cardboard at two places by means of wire or twine so that the stick strengthens the cardboard and projects far behind the cardboard to form a paddle; cover the cardboard with a thin ($\frac{1}{4}$ -inch) layer of smooth cotton bringing the two edges of the cotton together on the midline of the belly-side of the body along the stick; turn the skin, prepared in the usual way even to the legs, over the flattened body; with heavy shears cut off the posterior end of the cardboard to an appropriate shape; by means of monel metal wire or a large sacking needle and twine sew through each hind foot around the stick at two places so that the stick will support the two hind legs; with a single stitch secure each forefoot to the skin of the throat; sew up the slit in the belly; thrust a single pin (to be removed when the skin is dry) through the tip of each ear to secure the ears in the desired position; tie the label on the right hind leg; lay the skin away to dry. The skin need not be pinned down. Some advantages of this method are that it provides maximum support for the long hind legs which are wobbly and subject to breakage if otherwise prepared; a flattened body that is strong allows the specimen to be stored in less space than would be required if the body were deeper; and the method requires a minimum of time for stuffing.

Flattening the bodies of all specimens is desirable and the larger the specimen the thinner the body should be in relation to its width. Convenience in storing is one reason for flattening the bodies. In many collections of study specimens of mammals—for example, those in the University of Kansas Museum of Natural History—the storage cases have the runners so spaced that the distance between the topside of one tray-bottom and the underside of the tray-bottom next above is $1\frac{15}{16}$ inches. Sectional cardboard trays are used for specimens of shrew-size and mouse-size and reduce the available vertical space to $1\frac{1}{8}$ inches or slightly less. (The over-all depth of boxes to house skulls was the factor governing the vertical space between

trays. Information concerning these containers for cleaned skulls will be furnished upon request to the Museum but will not be dealt with in the present account.) Because there is only 1½ inches of vertical space between trays, the artificial bodies of the smaller mammals, say, chipmunks, are made in such a size that the over-all height of a specimen is less than 1½ inches. The pinning-trays in the collecting-chests (part of the field equipment) have end pieces 1½ inches high. When the trays of freshly stuffed specimens are stacked in the chest, any specimen that is slightly more than the specified height is at once compressed to 1½ inches. Once the skin has dried in that space the height will not increase much if any.

Specimens as large as jack rabbits and opossums may need to be slightly deeper than 1½ inches even if the artificial body is much flattened. The height of such a specimen should not exceed 2½ inches, because that height of body is almost the maximum that can be accommodated in a storage case by separating succeeding trays by one additional case-runner. The means of caring for these specimens in the trays of the collecting chest is to stack one empty pinning-tray upside down on the pinning-tray that contains the jack rabbits or opossums. In actual practice, however, we at the University of Kansas have been keeping the heights of even opossums and jack rabbits to 1½ inches.

In preparing study specimens of mammals, just as in doing other work, different methods will be found for gaining the same result. By slightly altering their methods from year to year two preparators who used the same methods to begin with will employ appreciably different methods after the lapse of several years. It is understandable therefore that no two preparators of experience use exactly the same methods—and this, I think, is as it should be, for each preparator should constantly strive to improve the quality of his product. The aim should be firm, symmetrical skins free of all fat.

It seems to me that every preparator takes pride in his specimens and, as I elsewhere once wrote, "I confess to a genuine personal gratification derived from the contemplation of one of my mammal specimens if well prepared, firmly made, and indelibly and accurately labeled. At such moments I have even considered the possibility that one or another of several particularly well-stuffed mice a century hence would be as deservedly spoken of and achieve more of favorable remembrance for me than some other accomplishment at the moment better appreciated by my associates."

These thoughts were expressed in connection with some recommendations against immersing skins in a salt-alum bath or treating them with only salt in order to preserve the skins until it was convenient to stuff them. Salt, or salt-alum solution, does alter the color of the pelage. My recommendation was against using these preserving agents even at a sacrifice in quantity of specimens. Also, at that time I expressed the opinion—still held—that the least that should be done for study skins subjected to the salt-alum treatment or to *any* treatment offering fair likelihood of resultant color change was to label the skins at the time of preparation with clear indication of departure from the conventional technique.

A departure that I regard as the lesser of several evils is the soaking of autumn-taken skins of ground squirrels in white gasoline in order to remove surplus fat that may have been released by scraping the flesh side of the skin.

Twelve to eighteen hours in gasoline removes the fat. Longer immersion tends to dehydrate the skin making it difficult to shape properly and making it so brittle after it is dried that it may break. For the skins of some ground squirrels almost ready for hibernation, I know of no substitute for gasoline, carbon tetrachloride, or other compound that removes fat. Such skins that I degreased only by scraping and applying cornmeal or fine sawdust to absorb the fat, although seemingly free of fat at the time of stuffing, later showed some greasiness that spread to several parts of the skin and down the string or thread of the label onto the label. Gross inspection of skins of mammals almost ready to hibernate suggests that there are fat cells in the skin of some as well as on the flesh side of the skin. Scraping and using an absorbent such as cornmeal removes most of the fat but not all of it. In spring when the same kinds of mammals are lean, the soaking of the skin in gasoline or in some other liquid compound is unnecessary—undesirable in fact.

When a skin has to be washed in soap and water for the purpose of removing dirt, bloodstains and the like, it can be dried more quickly if its final bath is in white gasoline instead of in water. This is because the gasoline displaces the water and the more volatile gasoline is quickly removed by cornmeal or sawdust in which the skin is buried or with which the skin is repeatedly dusted. Such a skin must be thoroughly dried until the fur is everywhere fluffy before being stuffed; otherwise the fur will always cling together in patches and be unsightly.

MAMMAL SKINS TO BE TANNED

Skins of mammals which at a later date are to be tanned or stuffed should be cased. Slit the skin from hind feet, down inside of hind legs to base of tail, and split tail full length. Do not open pads of feet on carnivores. In deer, open front legs from "elbow" to hoof.

Fat on skins should be scraped off before skins are stretched for drying. It is not necessary to soak such skins in gasoline.

Do not apply salt, alum or formalin to skins that are to be relaxed later. Stretch skins to dry, flesh side out, over a board, cardboard, frame of wire or two poles. When nearly dry, skins as large as those of deer may be rolled up for packing; skins of carnivores should be packed flat, with tails folded on body if desired, with a wisp of excelsior between skins. Be sure that skins dry and that no fly eggs are on the skins when they are packed. Label dried skins with skull-tags only.

PREPARATION OF SKULLS

Skulls of mammals should be severed from the vertebral column using extreme care not to injure the skull. Skulls the size of those of *Spermophilus franklinii* or larger should have the major part of the masseter muscle snipped off to allow the skull to dry quickly.

As soon as possible, skulls should be put in a glass container of cold water to soak for 12 hours, to remove the blood and loosen the brain. In very hot weather it may be necessary to change the water to prevent fermentation.

After removing the skulls from the water, blow out the brains with the aid of a hypodermic fitted with a blunt needle, or atomizer bulb fitted with a short rubber tube and blunt hypodermic needle.

Large and small skulls should not be strung on the same wire to dry. If, for example, squirrel and mouse skulls are strung together, some of the smaller skulls certainly will be more or less broken.

Above all, do not allow skulls to become fly blown. This is apt to occur when they are hung up to dry and while soaking, as some will float and thus be exposed to flies. Maggots do much damage by discoloring the bone, loosening the sutures, and obliterating data on tags. Never hang skulls in the sun—always in the shade and, if possible, where there is a breeze. When skulls are quickly dried, any fly eggs deposited will not hatch. If, due to damp weather, the skulls are apt to remain soggy, protect them by cheesecloth (when hung up) to exclude flies. When packing skulls for shipment, or when moving camp, use a container with plenty of air holes. Never put damp or even dry skulls in airtight containers; this causes sweating and maceration. For directions on cleaning mammal skulls, see *Jour. Mammalogy*, 14(4):372-374, 1933.

[In cleaning skulls of bird skins, avoid removing so much of the back end of the cranium as to loosen the articulations of the lower jaw. The lower mandible should be left in place so that the bill will close in normal position, preferably without tying. If tying is necessary, do not draw thread so tightly as to force lower mandible back out of the normal position against the upper. In birds larger than a tree sparrow if leg bones are broken, replace them with sticks so that the feet remain firmly anchored to body. In birds larger than a meadow-lark use an excelsior or tow body; but avoid *over* stuffing; with larger birds aim to make a flattish skin. Be faithful in removing *all* fat and grease.]

PREPARATION OF SKELETONS

When preparing skeletons, skin the body completely, which means to the tip of the tail and to the claws of the feet. The pads of the feet of mammals and the skin on the tarsi of birds are nearly impervious to the dermestid beetles. Always "draw" the animal and cut off all large muscles. Tag skeletons (each separate piece) in the same way as skulls.

Take care to save baculum, hyoid bones, marsupial bones, patellas, tip of tail, pygostyle, and alula, as these are easily lost. Do not remove tongue or eyes; they contain important bones.

When a skeleton has been roughed out, wrap it with thread or string so that the head and extremities will not be broken off when they are dry and brittle. The legs are pulled up along the body and the head brought back. A few wrappings of thread will suffice for small skeletons. Do not use so much thread that the beetles have difficulty in getting to the meat in the cleaning process. Do not wrap too tightly, as fresh bones are easily bent.

The higher the humidity the more thoroughly skeletons should be roughed out. Be sure to remove heart and lungs. A mammal skeleton the size of a squirrel's or larger should have skull detached and brains removed. Be sure to tie skull to body. A skeleton with skull and leg bones packed in rib basket is slow in drying. Keep sawdust off skeletons. Tie an additional label on skeletons of extremely young animals calling attention to them, so that they will receive extra care in cleaning. See that each separate part has a tag.

The same technique applies in most part to the preparation of skeletons of

reptiles and amphibians. Those of small size may require more careful protection to prevent breaking or crushing.

COLLECTING ECTOPARASITES

If ectoparasites are saved, exercise great caution not to collect ectoparasites that have crawled from one host-species to another. To prevent this each of the host animals should be placed in a separate bag of paper or plastic. A camel's hair brush, a pair of forceps, and a fine comb are the necessary instruments for the removal of ectoparasites. All parasites from a single host should be placed in a single vial containing seventy per cent alcohol. In the vial with the specimens place a label giving the field collector's initials and field number for the host. Vials should be stoppered with a plug of absorbent cotton and inverted into a larger container of alcohol. Care should be exercised in the removal of parasites. In removing parasites which are attached by their mouthparts to the host, either dissect away the skin to which they are attached or wait until they have relaxed and retracted their mouthparts as they generally do after the host becomes cold. The small mites and lice are most easily found by examining the host on a smooth homogeneously black background.

PRESERVATION OF AMPHIBIANS AND REPTILES

Amphibians

Live amphibians may be killed by immersing them in weak alcohol, 50-60%. After death, remove them from killing fluid before they become rigid and place them on a smooth, moist surface with the body in a lifelike position—the toes should be flattened and properly spread. Leave the animals in this position for a few minutes until they have become rigid; then drop them into a jar of formalin or alcohol so that they float free and are not distorted by pressure of other specimens. Avoid crowding specimens in containers. After they have become "fixed" attach tags of parchment or tin. At this time, the specimen should have a small slit made in the abdomen with a razor blade, or a pair of sharp-pointed scissors, or the specimen should be injected with a solution of preserving fluid stronger than that in which the specimen is immersed. In thus injecting specimens, avoid unnaturally distending them because this obliterates many of the important diagnostic characters.

After preservation for 48 hours in formalin, specimens may be transferred to 70% alcohol and kept in this preservative until they reach the laboratory. Under no circumstances wrap freshly killed specimens in cheesecloth; if it becomes necessary to separate specimens place them loosely in cheesecloth bags. The jar should be kept *completely* filled with liquid to prevent undue movement of the specimens during transportation.

Amphibians are best preserved in 1 part (full strength) of formalin to 6 parts of water; after from 48 to 72 hours wash the specimens in water for 48 hours and then transfer them to alcohol. They may be preserved directly in 70% alcohol. In either solution specimens need to be watched; make sure

they are not becoming hardened or are absorbing too much water. Each specimen must have adequate preserving fluid; placing many specimens in a limited quantity of alcohol may weaken it below the point of effective preservation.

Reptiles

Animals may be killed in the manner recommended for amphibians or by injecting alcohol or ether into the heart, which more often leaves the specimens relaxed than does anesthetizing them with chloroform or ether.

If specimens are to be injected use a solution of formalin (1 part to 5 of water) stronger than the solution in which the specimens are preserved. Do not inject enough fluid to distend the body beyond normal proportions.

Preferably in a flat bottomed container, lizards should be placed in a lifelike position with the fingers and toes straightened. The tail should be straightened, or if long, should be folded along the side of the body. After remaining in this position until rigid, specimens may be submerged in the preserving fluid.

If the specimen is not injected, make an incision through the body wall with a razor blade or a sharp-pointed pair of scissors.

Whether injected or not, the tail should be cut. In the attenuated fragile part of the tail make punctures with a needle.

Larger snakes should be neatly and symmetrically coiled, belly down with the head on the top of the coil. If coiled in small jars the pressure of the coils and the glass keep the preserving fluid from the skin thus allowing the specimen to spoil. Always have a sufficient quantity of fluid in contact with the specimens. Transfer to alcohol after 72 hours or after specimen is well fixed.

Turtles should be injected with strong formalin, and cuts made in the neck, limbs and tail. The legs and tail should be stretched out as much as possible.

If specimens of reptiles and amphibians die in the sack or have been killed, they may be softened by immersion in water for some time. They may become relaxed to the extent that they will make reasonably good specimens.

Packing and Shipping

Keep skins of birds or mammals with you until thoroughly dry. In preparing for shipment, take special pains to pack specimens tightly so that they will not move lengthwise of the box. Much of the smoothness and symmetry may be lost through loose packing.

In packing alcoholic material drain off fluid and wrap in cheesecloth so that each specimen is separate from its neighbor; place in cans with tight-fitting tops, filling in extra space with excelsior to prevent specimens from moving about and rubbing against one another. Pour in just enough fluid to keep packing material moist. The same care in this respect is as necessary when merely changing camp as during shipment to Museum. Where possible, leave lizards and amphibians directly in the preserving fluid (the containers completely filled) when being transported.

COLLECTING AND PRESERVING FISHES

References: Hubbs, Carl L., and Lagler, Karl F., "Fishes of the Great Lakes Region," Cranbrook Inst. Sci., Bull. 26: xi + 186 pp., illustrated; 1947. Lagler, Karl F., "Freshwater Fishery Biology," Wm. C. Brown Co., Dubuque, Iowa, x + 360 pp., 172 figs., 1952.

The following detailed instructions are intended especially for the serious student of fishes, who wishes to derive a maximum of information from his collecting effort. The amateur collector whose interests are mainly in keeping a few fishes for casual observation, or in obtaining an identification of some species unknown to him, may lack the time or facilities for following all these recommendations. Although he should read fully these instructions and follow them insofar as possible, he can do a certain amount of collecting quickly, easily, and economically. The essentials are formaldehyde (obtainable in many drugstores) and a jar to contain the specimens. The formaldehyde, as purchased, must be diluted with approximately nine parts of water before it is used. Ordinary rubbing alcohol can be substituted for the formaldehyde, but is much less desirable and should not be diluted. If necessary, the specimens can be left in either of these solutions permanently.

If the collector has arranged with the Curator at the Museum to send his fishes to the Museum for identification, they may be sent in the following ways: wrap the specimens in soft cloths moistened with formaldehyde or alcohol, and pack carefully in a paint can or other tight, friction-sealed can, which can be sent by mail or express without danger of drying of the specimens; or place the specimens with moistened cotton or cloth in a plastic bag, tie the open end of the bag tightly, and pack the bag carefully in a wooden box for shipment. The specimens should, of course, always have labels stating where they were caught, when, and by whom.

Methods of Collecting

Fishes may be collected by a variety of devices. Hook-and-line, seines, gill nets, trammel nets, hoop- or fyke-nets, traps, poison, and electrical shockers are devices commonly used in fresh water. Each of these devices is selective, in some degree, of certain kinds or sizes of fishes. Therefore it is desirable to employ several methods to obtain a representative sample of the total fauna from any given locality. Poison, such as powdered Derris root or Cube root mixed with water, so as to make a soupy solution, is used to best advantage in backwater areas along streams or in small bays of lakes, where dispersal of the poison can be restricted. Portable electric shockers are the most effective devices for sampling clear, fast-flowing, rocky streams. Gill nets, hoop nets, and traps are most useful for sampling large, deep lakes or sluggish streams, although hoop nets may also be used effectively in relatively fast-flowing, deep water. All such nets are made in several mesh sizes. Gill nets are highly selective of limited kinds and sizes of fishes unless a series of different mesh sizes is used.

For qualitative surveys most collectors rely on seines, of one-quarter-inch mesh, in lengths of 10 feet to 25 feet. A seine 4 feet or 6 feet long, made from bobbinet or nylon screening material, is especially useful for collecting along brushy shores or in riffles in streams. Bag seines, with a long pocket of netting in the middle, are good for effective sampling of lakes or large rivers.

Stretch all nets to dry as soon as possible after use. Rapid drying greatly reduces the rate of deterioration of a net. The life of the net can be prolonged also by treatment with a preservative such as copper naphthenate.

Field Containers

The most satisfactory field containers are wide-mouthed, galvanized milk cans with lids and wire bails. The can need not be large, but should be tall enough to contain the largest specimen likely to be included in the sample. Wide-mouthed glass "pickle" jars in gallon size, or half-gallon fruit-canning jars, also make suitable and inexpensive containers, but are subject to breakage and consequent loss of the collection, especially in fast-flowing, rocky streams.

Collecting and Preserving

Fishes should be killed immediately upon capture in a preservative mixture consisting of one part 40 per cent formaldehyde and nine parts water. All specimens may be placed in the same container. Those more than six inches long should be slit open along the *right side* of the abdomen to facilitate penetration of the preservative. Smaller fishes, or extremely slender ones, need not be incised or otherwise prepared for fixation. Fishes placed in preservative while still alive make much the best specimens. The largest specimens thus preserved should be removed for incision after they have been killed, and then placed back in the preservative.

The collector should overlook no available habitats in any body of water he works. He should thoroughly investigate shallow riffles, undercut banks, and the depths of pools in proportion to their occurrence in the situation being studied. Kicking or dislodging large stones or submerged debris often yields species whose presence would not be discovered if these methods were neglected. Just as some fishes are selective as to habitat, others are active and susceptible to capture at different times of day. For this reason dual collections obtained from the same locality at night and in the daytime are desirable. The time interval in which the sample was taken always should be stated in the field notes.

The collector should strive to obtain a representative sample of the various species and size groups constituting the population, and should preserve a fixed percentage of the total number of individuals of each species captured. Because nearly all collectors deviate from this practice to some extent in order to secure adequate series of rare species, the degree to which the actual relative abundance was biased by the collector's selectivity should be indicated on the sheet of field data. This may be done in a general sense by assigning to each species a number corresponding to its position in descending order of abundance, or by application of one of the terms, "abundant," "common," "frequent," "scarce," or "rare."

Labels and Field Notes

Immediately after the collection is completed, prepare field notes and a label for the container of specimens. These should be written in Higgins Eternal Ink or Higgins Engrossing Ink, the latter having the advantage that it need not be washed before being placed in the preservative solution. Data on the label should include the state, county, section, township, and range (or comparable information where these categories are not applicable), the

name of the stream or lake from which the sample was taken, the date of capture, and the names and field numbers of the collectors. The field notes should be more comprehensive, as indicated below and in other sections of these instructions. The collector's field number, the date, and the time interval in which the collection was made should be entered at the top of the sheet. The locality, the method of capture, the pH of the water, and the temperature of the air and water should then be recorded. Additional data will vary depending upon the type of habitat being studied. Desirable notes of collections from streams include: turbidity and evidence of pollution; average width, average depth, and maximum depth of stream; ratio of riffles to pools, and the average length of each; rate of flow in feet per second (this may be estimated by recording the time required for twigs thrown into the water to traverse a measured length of stream); volume of flow in cubic feet per second (rate of flow \times average depth \times average width); type of stream-bottom materials including the proportions made up by bed rock, boulders, rubble, gravel, sand, or mud; kinds and abundance of aquatic plants and macroscopic invertebrate animals; and the extent and nature of streamside cover. Finally, a list of the species taken, and recognized, should be recorded, together with notes on the habitat occupied by each species, and any special notes on coloration, spawning activity, etc., observed in individual specimens. Detailed notes have not been made on some of our commonest fishes. Descriptions of coloration, especially of colors developed during the spawning season, are important, because the fishes fade in formaldehyde or alcohol, and are best described from living or freshly-preserved specimens.

Subsequent Handling of Specimens

After the specimens have been in the preservative solution for three days to a week (depending upon the size of the individuals), soak them thoroughly in water for two to three days. Change water several times in this interval. Transfer specimens to 70 per cent ethyl alcohol, or 50 per cent isopropyl alcohol. Change this alcohol, or restore it to the proper strength, before the specimens are placed in permanent storage. Thereafter, check the strength of the alcohol every six months and maintain proper strength. If this is not done, evaporation from the jars eventually will reduce the percentage of alcohol and the specimens will become soft.

The collection may be sorted, separating the species represented, at any time after washing. Consult the field notes and correct the list of species, if necessary, during the sorting process. It is usually desirable to reserve a single container for all specimens of each species obtained in a single collection, and to catalogue the species by "lots," rather than individually. Suitable storage containers include fruit-canning jars in one-half pint to one-half gallon sizes, patent-lip vials in 4-dram and 8-dram sizes, and earthenware crocks or churns in 5-gallon to 20-gallon sizes. Seal earthenware lids on crocks and churns with beeswax and paraffin mixed to a putty-like consistency. Screw-type, metal-lid jars are undesirable, but may be used if new lids with gaskets are available for replacement as the old ones become rusty.

A label, written with Higgins Eternal Ink, or Engrossing Ink, stating the name of the species, the catalogue number, the number of specimens, the locality, the collector, and the date of capture should be placed in the container with each lot of specimens. Space may be saved by utilizing vials for short

series of small specimens, and placing in a larger jar several vials of the same species, taken at different times or localities. Each vial must contain its own label and alcohol, and its mouth must be tightly plugged with cotton. Efficient use of space may also require storage of large specimens from several collections in the same container. Such specimens must be catalogued individually and labels of tin or of plastic tape must be attached securely to each specimen by sewing them to the lips, opercle, or caudal peduncle.

LIFE HISTORY NOTES

(Birds, Mammals, Reptiles, Amphibians, Fishes)

Markings and coloration (meanings apparent as associated with significant circumstances; directive, disruptive, concealing).

Speed (gait, climbing, swimming, walking, running, flying); tracks.

Abundance: by impression; censuses.

Plant associates: habitat; environment (define distinctive ecologic niche or biotope in which each animal is found).

Range (home range or "cruising radius" of individual, topographic and geographic range of species, indications of change in range).

Call-notes or voice (interpretations whenever circumstances give any clue); "songs" of birds.

Migrations (regular, irregular, local, altitudinal, geographical); movements and flight.

Degree of gregariousness (including "social instincts"); manner or means of communication (as voice, gesture, touch, and smell-signals).

Nests, dens and lairs; breeding habits (including number of young, length of breeding period, mating; whether promiscuous, polygamous, monogamous; relations of individuals of family group to each other); modes of locating nests or homes; sanitation; solicitude; reactions of young; care of young; mastology (distribution of mammary glands).

Boldness; belligerence; intolerance; shyness.

Food-habits; forage range; manipulation of food; storage. Scatology (dung or feces).

Acuteness of the various senses (touch, taste, sight, hearing, smell, and direction).

Enemies; disease (parasites, internal and external).

Odd partnerships; commensalism; any biotic interrelationships apparent.

Age (length of life of individual).

Refuges: from enemies; for resting or roosting.

Dormancy: hibernation or estivation; places where undergone.

FINAL SUGGESTIONS

Read above suggestions every few days, devoting half an hour or so to thoughtful consideration of the objects of our field work, which are: To ascertain everything possible in regard to the natural history of the vertebrate life of the regions traversed, and to make careful record of the facts gathered in the form of specimens and notes, to be preserved for all time. All this is for the *information* of others; strive to make your records in all respects clearly intelligible. Remember that the value of our manuscripts increase as the years go by and faunal changes take place. Some earlier note-books describe conditions now vanished in the localities with which they dealt.

SUGGESTIONS FOR COLLECTING VERTEBRATE FOSSILS

References on field techniques: Camp, C. L., and Hanna, G. D. "Methods in Paleontology," Univ. California Press, Berkeley, Calif., 1937. Hermann, A., "Modern Laboratory Methods in Vertebrate Paleontology," Bull Amer. Mus. Nat. Hist., vol. 26, pp. 283-381, 1909. Simpson, G. G., "How Fossils are Collected," Natural Hist., vol. 39, pp. 329-334, 1937.

Equipment

For general prospecting, each person should be equipped with the following: Marsh pick, awl (protect point with small cork), whisk broom, small paint brush, wrapping paper, paper bags, string, field labels, tobacco tin, Scot [toilet] Tissue, large pocket knife, collecting bag, notebook, and several 8H pencils. Many collectors carry in addition to the above such items as shellac bottle with enclosed brush, rice paper, trowel, and hand lens. Equipment necessarily varies with field conditions.

Finding Fossils

In prospecting, work upstream and from base of an exposure upward. Save all fragments until you are sure the lead is valueless. If material is located which is worth collecting, save these fragments and be sure they can be identified with the specimen. If the size of the area prevents exhaustive searching then follow stream courses and ridge-tops. In any case do not remain on the same stratigraphic level until after fossil zones are established. In areas of tilted and folded strata this means that the collector should work back and forth across the strike of the beds.

A specimen is of little value unless the geographic location and stratigraphic position are known as exactly as possible. Hence obtain as much of the following data as possible for isolated specimens, and as much as is pertinent for any specimen: (1) geologic age (2) sketch map showing location and columnar (vertical) section indicating stratigraphic position (3) land location to quarter quarter-section (4) triangulation to prominent land marks if a Brunton compass is available (5) lithology and conditions of deposition. If necessary collect and label a rock sample. In locating specimens avoid such expressions as "brown house," "Jones Ranch" although these may be used as supplementary information. Do not attempt to collect specimens with inadequate equipment. Mark site plainly, cover specimen if necessary, and return when the proper equipment is available.

Any collector should be alert to reports of fossils or of objects thought to be fossils and should investigate such reports.

At least two groups of youths of boy scout age that channeled their outdoor activities to collecting fossils have recently made important discoveries. In the process they initially learned the techniques for removing fossils and of course learned by their own efforts a substantial amount of geology and biology.

Excavation of Specimens

In working a quarry or taking out large specimens avoid tunneling or undercutting specimen or fossil layer. Remove all overburden for a considerable distance on all sides away from area of immediate work. If the presence of a microfauna is indicated, dry the matrix and sieve it. Disintegrate silt or clay in running water to recover material of small size. Frequently, specimens will have to be treated with white shellac thinned with alcohol. Use only gum arabic for specimens in chalk. Use thin alvar for gluing and on fragile specimens, but allow specimen to dry before applying the alvar. Do not leave specimens exposed overnight. Lay paper over specimens and cover with earth.

If specimen must be jacketed, undercut the block slightly before applying jacket. Cut loose-weave burlap into strips approximately four inches wide and soak in water. Cover exposed bones with two or three layers of wet toilet paper. Soak burlap strips in thin moulding plaster and bandage the block. Allow plaster to set thoroughly. Complete undercutting of specimen, turn block over, trim, and bandage the under surface. Do not smooth raw plaster over jacket. Leave plenty of matrix on specimen—that is to say, do not attempt to prepare specimen in field. Take notes in field in regard to condition of specimen or anything else which will assist the laboratory preparator in removing the specimen.

Field Notes

Each person should keep a combined daily journal and field book in which is entered such data as: time of arrival and departure, weather (in foreign countries especially), route traveled, exposures visited, exact localities, sketches, notes on geology, measured sections, specimens collected with locality and your catalogue field number, names, addresses, and comments on people met during field work. On a museum field trip the notes as well as the specimens are the property of the Museum. It is well to remember that the entire party receives credit for material found or collected by a member; do not try to outrace other members of the party either during prospecting or quarry operations.

In addition, if the party is large and operating over a long period of time, catalogue all specimens in a separate field book. The field numbers should also be attached to the specimen or engraved in the plaster packets. Each collector whether working as a group member or alone uses his own field numbers which are consecutive and carry his initials. Thus J.E.D. 30 indicates the thirtieth specimen collected by John Doe during his Museum career.

The field journal should be kept on the standard note book paper. Use only a very hard pencil (7H to 9H) or Higgins Eternal Ink. Write only on one side of note book paper. Each page should carry a page number in the upper right-hand corner, and your name and year in the upper left-hand corner. Leave sufficient margin for future binding.

GLOSSARY

abdomen, *n.*—That part of the body (excepting the back) between the thorax (rib-basket) and the pelvis.

alveolar, *adj.*—Of or pertaining to an alveolus (plural alveoli), a small cavity or pit, as a socket for a tooth. Alveolar length of a tooth-row therefore denotes the length of the row of the teeth, taken from the posteriomost place where the back tooth emerges from the bone to the anteriormost point where the front tooth in the row emerges from the bone—the over-all length of the bony sockets for the row of teeth.

annulation, *n.*—A circular or ringlike formation, as of the dermal scales on the tail of a mammal where one ring of scales that extends entirely around the tail is succeeded, posteriorly, by other rings.

arboreal, *adj.*—Inhabiting or frequenting trees—contrasted with fossorial, aquatic, and cursorial.

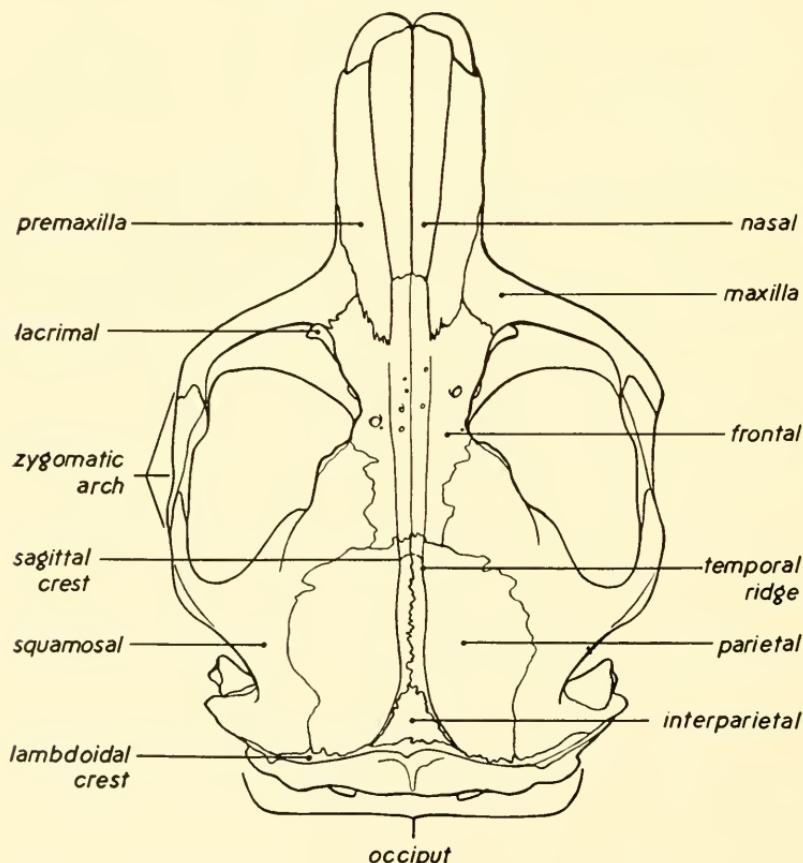


FIG. 90. Parts of the skull in dorsal view of the Townsend Pocket Gopher, *Thomomys townsendii nevadensis*, from Malloy Ranch, 5 mi. W Austin, Nye Co., Nevada, No. 37073 MVZ, ♂, $\times 2$. This and the following figures are, with slight modifications, from "Mammals of Nevada" by E. Raymond Hall, Univ. California Press, Berkeley, 1946.

auditory bulla (plural, *auditory bullae*).—A hollow, bony prominence of rounded form (in most mammals formed by the tympanic bone) partly enclosing structures of the middle and inner ear. See figure 91.

basal length.—Distance on skull from the anteriormost inferior border of the foramen magnum to a line connecting the anteriormost parts of the premaxillary bones. See figure 97.

basilar length.—Distance on skull from the anteriormost inferior border of the foramen magnum to a line connecting the posteriormost margins of the alveoli of the first upper incisors. See figure 97.

bead, *n.*—A salient, rounded cordlike projecting ridge of bone, as in certain rodents where the superior border of the orbit is beaded.

braincase, *n.*—The part of the skull enclosing the brain.

calccar, *n.*—In bats a process connected with the calcaneum (heel bone), helping to support the edge of the fold of skin that extends between the leg and tail.

cancellous, *adj.*—Having a spongy or porous structure.

canine, *adj.* & *n.*—Of, pertaining to, or designating the tooth next to the incisors in mammals. See figure 97. Of or pertaining to dogs or to the family Canidae.

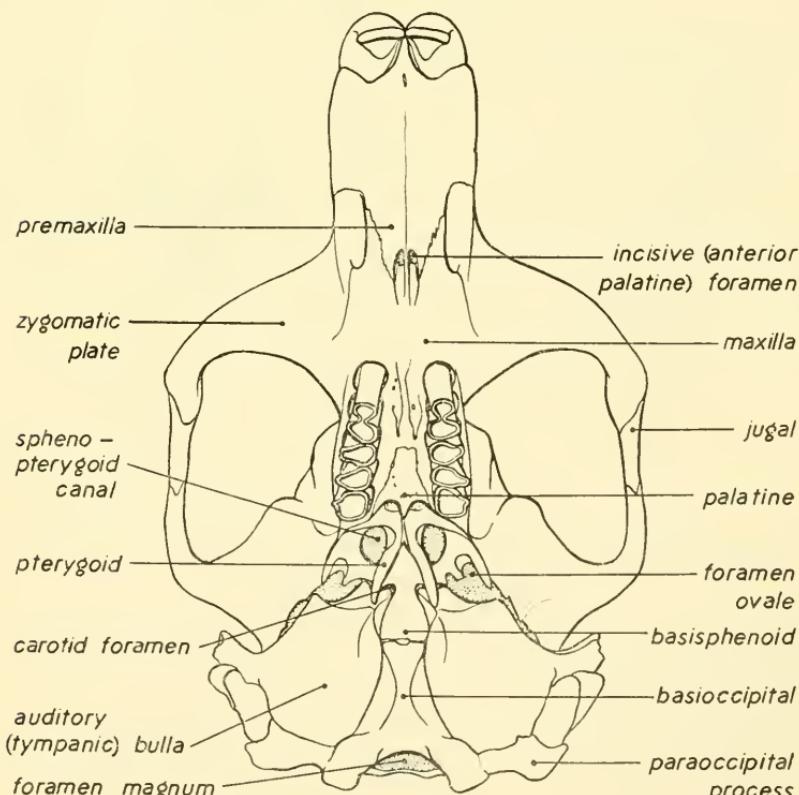


FIG. 91. Parts of the skull in ventral view of the Townsend Pocket Gopher, $\times 2$ (same specimen shown in fig. 90).

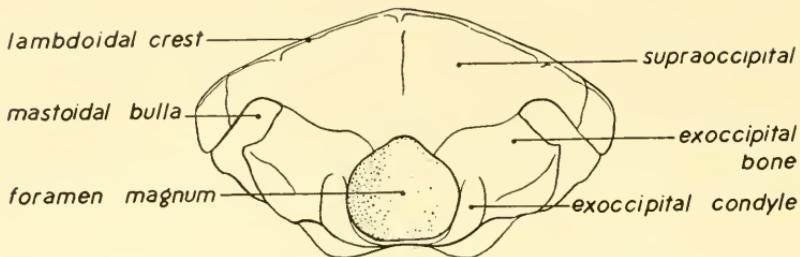


FIG. 92. Posterior view of the cranium of the Townsend Pocket Gopher, $\times 2$ (same specimen shown in fig. 90).

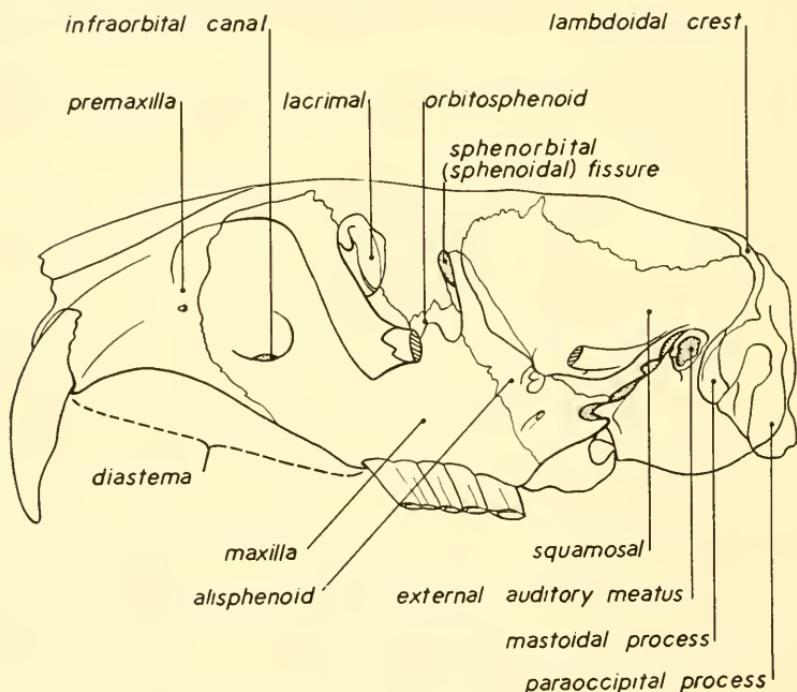


FIG. 93. Lateral view of left side of skull of Townsend Pocket Gopher, $\times 2$ (same specimen shown in fig. 90).

carnivore, *n.*—An animal that preys on other animals; an animal that eats the flesh of other animals; especially any mammal of the Order Carnivora.

cheek-teeth, *n.*—Teeth behind the canines.

conch (plural conchs), *n.*—The external ear of a mammal; sometimes the spelling in concha (plural conchae); the origin of both spellings is conch or konch, originally a bivalve shell of a marine mollusk.

condylar (articular) process.—On a mandible, the process ending in the articular condyle.

condylobasal length.—Least distance on skull from a line connecting the posteriomost projections of the exoccipital condyles to a line connecting the anteriormost projections of the premaxillary bones. See figure 97.

coronoid process.—The upward projecting process of the posterior part of the mandible, giving attachment on its outward side to the masseter muscle and on its inner side to the temporal muscle. See figure 95.

dental formula (plural formulae).—A brief method for expressing the number and kind of teeth of mammals. The abbreviations i. (incisor), c. (canine), p. or pm. (premolar), and m. (molar) indicate the kinds in the permanent dentition, and the number in each jaw is written like a fraction, the figures above the horizontal line showing the number in the upper jaw, and those below, the number in the lower jaw. The dental formula of an adult coyote is i. $\frac{2}{3}$; c. $\frac{1}{1}$; p. $\frac{4}{4}$; m. $\frac{2}{3}$.

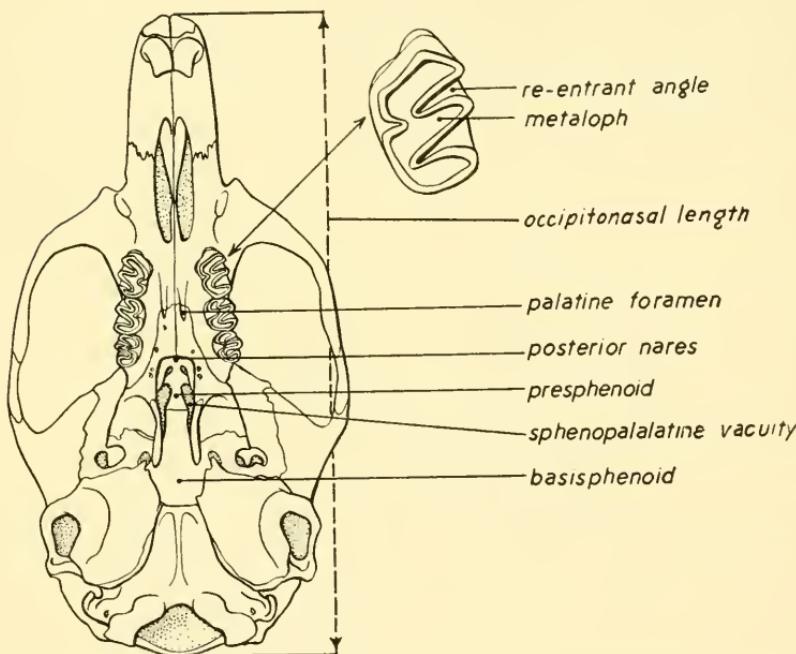


FIG. 94. Parts of the skull in ventral view of the Desert Wood Rat, *Neotoma lepida lepida*, Baker Creek, 8500 ft., White Pine County, Nevada, $\times 2$.

dentine, *n.*—A calcareous material harder and denser than bone which composes the principal mass of a tooth.

dentition, *n.*—The teeth, considered collectively, of an animal.

deutocone, *n.*—One of the cusps of a premolar tooth of a mammal corresponding in position (anteromedial) to the protocone of a true molar. See figure 98.

diastema, *n.*—A vacant place or gap between teeth in a jaw. See figure 93.

diurnal, *adj.*—Active by day—opposed to nocturnal.

enamel, *n.*—Of teeth, the hardest substance of the mammalian body and forming a thin layer that caps or partly covers a tooth.

faeces (singular and plural), *n.*—Intestinal excrement.

feces (see faeces).

femur (plural, femora), *n.*—The proximal bone of the hind limb.

foramen magnum.—The large opening in the back of a skull through which the spinal cord passes to become the medulla oblongata of the brain. See figure 92.

forearm, *n.*—The part of the forelimb between the elbow and wrist.

fossilorial, *adj.*—Fitted for digging.

frontal, *adj. & n.*—Pertaining to or designating the bone (paired) immediately in front of the parietal bone and behind the nasal. See figure 90.

gestation period.—The period of carrying young in the uterus, as applied to placental mammals; the period of pregnancy.

guard hairs.—The stiffer, longer hairs which grow up through the limber, shorter hairs (fur) of a mammal's pelage.

habitat, *n.*—The kind of environment in which a species of organism is normally found.

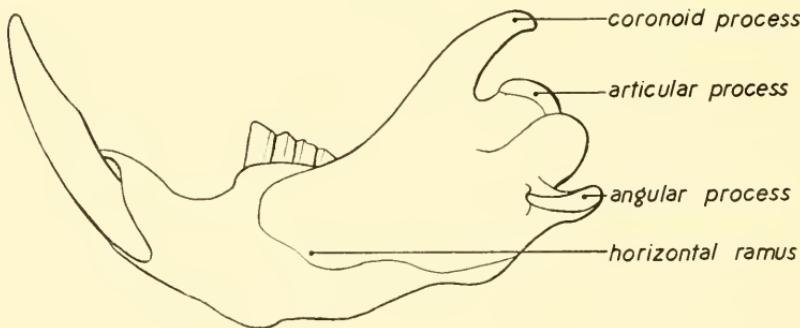


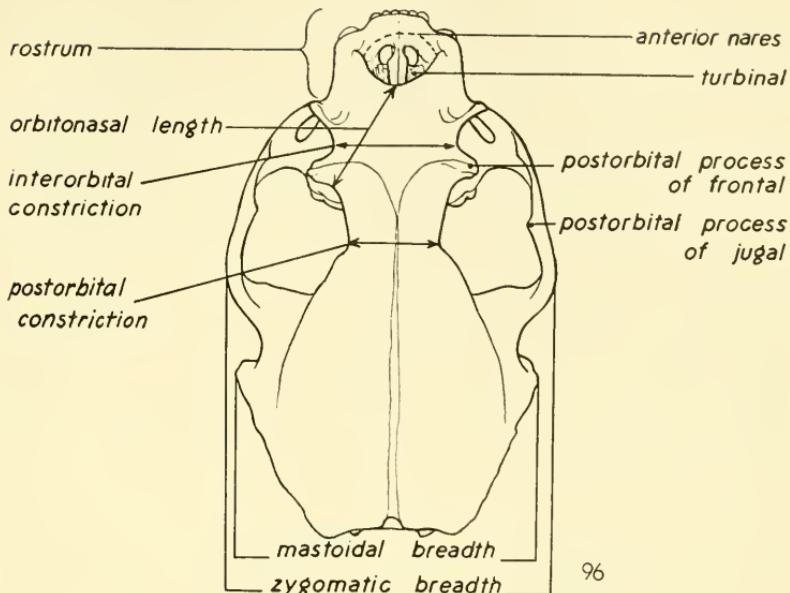
FIG. 95. Parts of the left lower jaw in lateral view of the Townsend Pocket Gopher, $\times 2$ (same specimen shown in fig. 90).

hamular process of pterygoid.—A hooklike process on the pterygoid bone. See figure 91 for pterygoid bone.

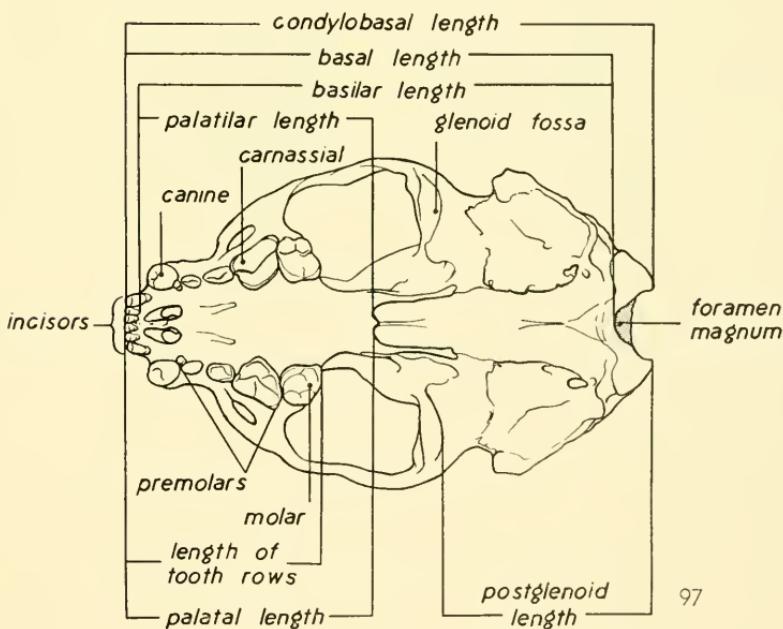
hibernation, *n.*—Of an animal, torpidity especially in winter; the bodily temperature approximates that of the surroundings; the rate of respiration and the heart beat ordinarily are much slower than in an active mammal.

horizontal ramus.—In a lower jaw, the ramus bearing the teeth, and anterior to the vertical ramus.

incisive foramina.—The anterior palatine foramina (singular foramen), of which there are two, in the bony roof of the anterior part of the cavity of the mouth at the juncture of the premaxillary bones and maxillary bones; transmit nasal branches of palatine arteries and nasopalatine ducts of Jacobson. See figure 91.



96



97

Figs. 96 and 97. Parts of the skull of the River Otter, *Lutra canadensis sonora*, Colorado River, 8 mi. upriver from Needles, San Bernardino Co., California, ♂, No. 61451 MVZ, $\times \frac{1}{2}$. Fig. 96 is dorsal view and fig. 97 is ventral view.

incisor, *adj.* & *n.*—Pertaining to or designating one of the teeth in front of the canine tooth; those in the upper jaw invariably are in the premaxillary bone. See figure 97.

infraorbital canal.—A canal through the maxillary bone from the orbit to the face. See figure 93.

inguinal, *adj.*—Pertaining to or in the region of the groin.

insectivorous, *adj.*—Eating insects; preying or feeding on insects.

interfemoral membrane.—In a bat the fold of skin stretching from hind legs to tail.

interorbital constriction.—The least distance across the top of the skull between the orbits (eye sockets). See figure 96.

interorbital region.—The region between the eye sockets; the region of the skull between the rostrum and the braincase.

interparietal, *adj.* & *n.*—Pertaining to or designating the bone (rarely paired) immediately in front of the supraoccipital bone and between the two parietal bones. See figure 90.

litter, *n.*—The two or more young brought forth at one birth by a female mammal.

loph, *n.*—A combining form used as the terminal part of certain words and denoting the ridges (or areas) composed of several cusps and styles on the occlusal face of a tooth, as protoloph. See metaloph in figure 94.

M2.—Designation of the second true molar in the upper jaw of a mammal.

mammae (singular mamma), *n.*—The glandular organs for secreting milk.

mastoid, *adj.* & *n.*—Designating or pertaining to the mastoid bone (paired) or its process. This bone is bounded by the squamosal bone, exoccipital bone, and tympanic bone. See figures 93 and 96.

maxillary breadth.—Width of skull from some designated place on the lateral face of the right maxillary bone (maxilla) to the corresponding place on the left maxillary bone; in shrews, across the ends of the zygomatic processes of the two maxillary bones.

maxillary tooth-row.—The row of teeth in one maxillary bone; in most mammals all of the premolars and molars on one side of the upper jaw.

metabolic water.—Water formed as an end product of combustion of food stuffs in an animal's body.

metacarpal, *adj.* & *n.*—Of or pertaining to a metacarpal bone. A bone of the hand or forefoot between the wrist and fingers; when all of the digits are present there are five more or less elongated metacarpal bones, one at the base of each digit.

molar, *adj.* & *n.*—Of or pertaining to a molar tooth. One of the teeth behind the premolar teeth; for example, in the opossum three on each side in upper jaw and in lower jaw, making twelve in all; a molar tooth is not preceded in embryological development by a deciduous (milk) tooth.

molt (moult), *n.* & *v.*—In a mammal, the act or process of shedding or casting off the hair, or outer layer of skin or horns; most mammals shed the hair once, twice or three times annually. The castoff covering (*obsolete*). As a verb: To be shed (*intransitive*) or to shed (*transitive*).

nasal, *adj.* & *n.*—Of or pertaining to the nose, as a nasal bone (paired) on the dorsal surface of the skull at its anterior end. A nasal bone. See figure 90.

nocturnal, *adj.*—Active by night—opposed to diurnal.

occipitonasal length.—Least distance between two vertical lines, one touching the posteriormost part of the skull above the foramen magnum (opening for the spinal cord) and the other touching the anteriormost part of the nasal bones or a nasal bone.

occlusal, *adj.*—Of or pertaining to the grinding or biting (occluding) surface of a tooth.

opposable, *adj.*—Capable of being placed opposite something else; said of the first toe of an opossum in the sense that it can be placed opposite each of the other toes on that same foot.

orbit, *n.*—The cavity in the skull in which the eye and its appendages are situated; the eye socket.

osseous, *adj.*—Composed of, or resembling, bone; bony. Osseous tissue is bony tissue.

overhairs, *n.*—The longer hairs of the pelage of a mammal that project above the fur (shorter hairs).

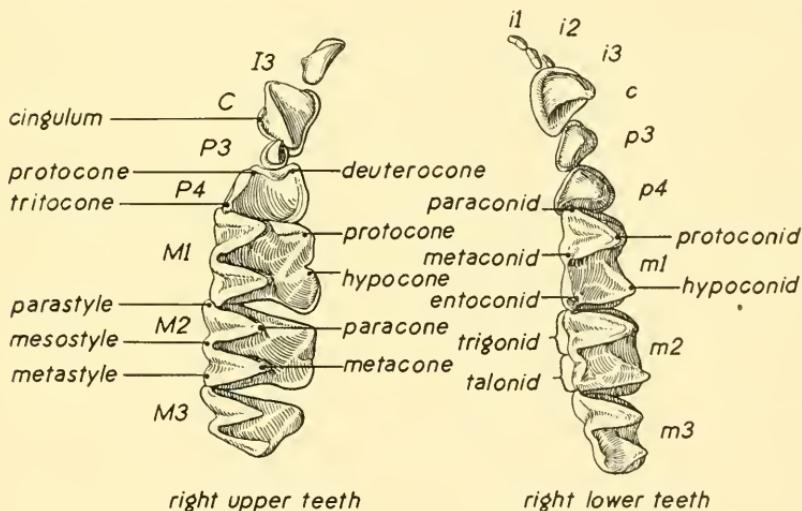


FIG. 98. Occlusal views of teeth of Mexican Free-tailed Bat, *Tadarida brasiliensis mexicana*, Greenmonster Canyon, Nye Co., Nevada, showing names applied to parts, $\times 7\frac{1}{2}$.

P3.—Designation of the third (next to last) premolar in the upper jaw of a mammal. Capital letters designate teeth in the upper jaw and lower case (non-capital) letters designate teeth in the lower jaw. See figure 97.

palatal, *adj.*—Of or pertaining to the palate (as used in the foregoing account, the bony roof of the mouth made up of two palatine bones, two maxillary bones, and two premaxillary bones).

palate, *n.*—The roof of the mouth, consisting of the structures that separate the mouth from the nasal cavity. The bony palate is composed of the following bones: premaxillae, maxillae, and palatines.

parietal, *adj.* & *n.*—Pertaining to or designating the parietal bone (paired) roofing the braincase. This bone is behind the frontal bone and in front of the occipital bones. See figure 90.

pectoral, *adj.*—Of, pertaining to, or situated or occurring in or on, the chest.
 pencil, *n.*—Tuft of fur or hair, as a black pencil on the end of the tail of a mammal.

phalanx (plural, phalanges), *n.*—A bone, in a finger, distal to the metacarpus or a bone, in a toe, distal to the metatarsus.

pinna (plural pinnae), *n.*—The projecting part of an ear.

postorbital, *adj.*—Situated behind the eye, as postorbital process of the frontal bone or postorbital process of the jugal bone. See figure 96.

postauricular, *adj.*—Situated behind the auricle (pinna) of the ear, as a postauricular patch (ordinarily referring to a patch of fur differing in color from surrounding fur).

premaxillary, *adj.*—Of or referring to the premaxilla, a bone (paired), in the mammalian skull bearing the incisor teeth of the upper jaw; the premaxilla is situated in front of the maxilla. See figure 90.

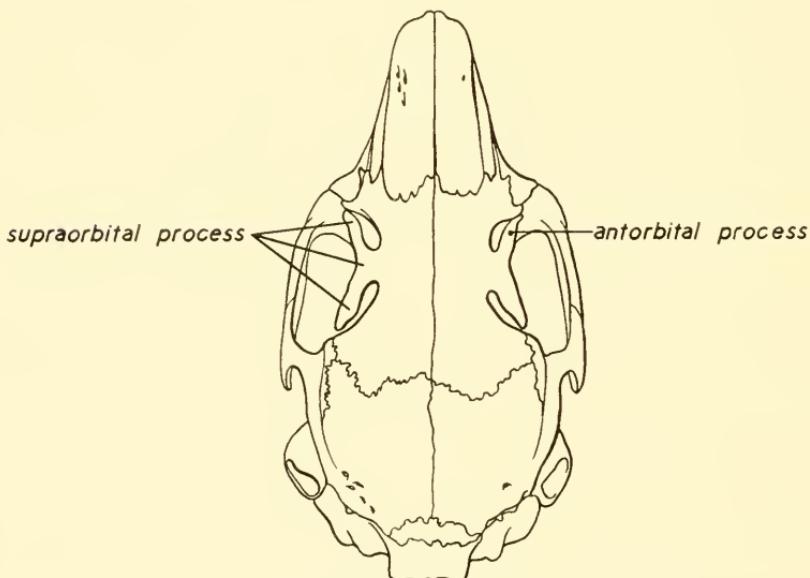


FIG. 99. Parts of the skull of the Pigmy Rabbit, *Sylvilagus idahoensis*, Millett P. O., Nye Co., Nevada, $\times \frac{1}{2}$.

premolar, *adj. & n.*—Designating or pertaining to one of the teeth (a maximum of 4 on each side of upper jaw and lower jaw of placental mammals, or 16 in all) in front of the true molars. When canine teeth are present, premolars are behind these teeth; premolars are preceded by deciduous teeth, and in the upper jaw are confined to the maxillary bone. See figure 97.

re-entrant angle.—An infold of the enamel layer on the side, front, or back of a cheek-tooth, as in a molar of a muskrat or wood rat. See figure 94.

rostrum, *n.*—Of a mammalian skull, the part projecting in front of the orbits.
 rut, *n.*—The breeding period, as in deer.

sagittal crest.—The ridge of bone at the juncture of the two parietal bones resulting from the coalescence of the temporal ridges; in old individuals of many species of mammals the crest extends from the middle of the lambdoidal crest anteriorly onto the frontal bones and divides there into two temporal ridges each of which extends anterolaterally on the posterior edge of the postorbital process of the frontal bone. See figure 90.

saliva, *n.*—The fluid secreted by the glands discharging into the mouth.

subauricular spot.—A spot, patch of hair, distinctively colored immediately below the ear.

supraorbital process of frontal.—The process of the frontal bone on the top rim of the orbit, as in a rabbit. See figure 99.

tarsus, *n.*—The ankle.

temporal ridge (paired).—A curved, raised line on the side of the braincase marking the upper limit of attachment of the fascia of the temporal muscle. The temporal ridge is prominent on the parietal bone, frequently extends forward onto the frontal bone, and in some kinds of mammals extends backward onto the interparietal bone. When present, the sagittal crest is formed by the coalescence of the two temporal ridges. See figure 90.

terrestrial, *adj.*—Inhabiting the land, rather than the water, trees or air.

tibia (plural tibiae), *n.*—The inner and usually the larger of the two bones of the hind limb (leg) between the knee and the ankle.

torpid, *adj.*—Having lost most of the power of exertion; dormant. A ground squirrel is torpid when it is hibernating.

tricolor, *adj. & n.*—Having three colors. Said of hair on back of mammal when hair has three bands each of a different color.

type locality.—The place where a type specimen was obtained.

underfur, *n.*—The short hair of a mammal; in temperate and boreal climates the underfur ordinarily is denser, made up of more hairs, than the longer and coarser overhair.

underparts, *n.*—The underneath (ventral) side of a mammal (not the back or sides), as of a woods mouse with white *underparts*.

upper parts.—The top (dorsal) surface and all of the sides (not the belly, chest or throat), as of a woods mouse with reddish-brown *upper parts*.

uropatagium, *n.*—The interfemoral membrane of a bat; that is to say, the fold of skin that stretches from the hind legs to the tail.

zygomatic breadth.—Greatest distance across zygomatic arches of cranium at right angles to long axis of skull. See figure 96.

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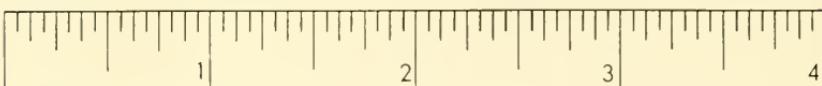
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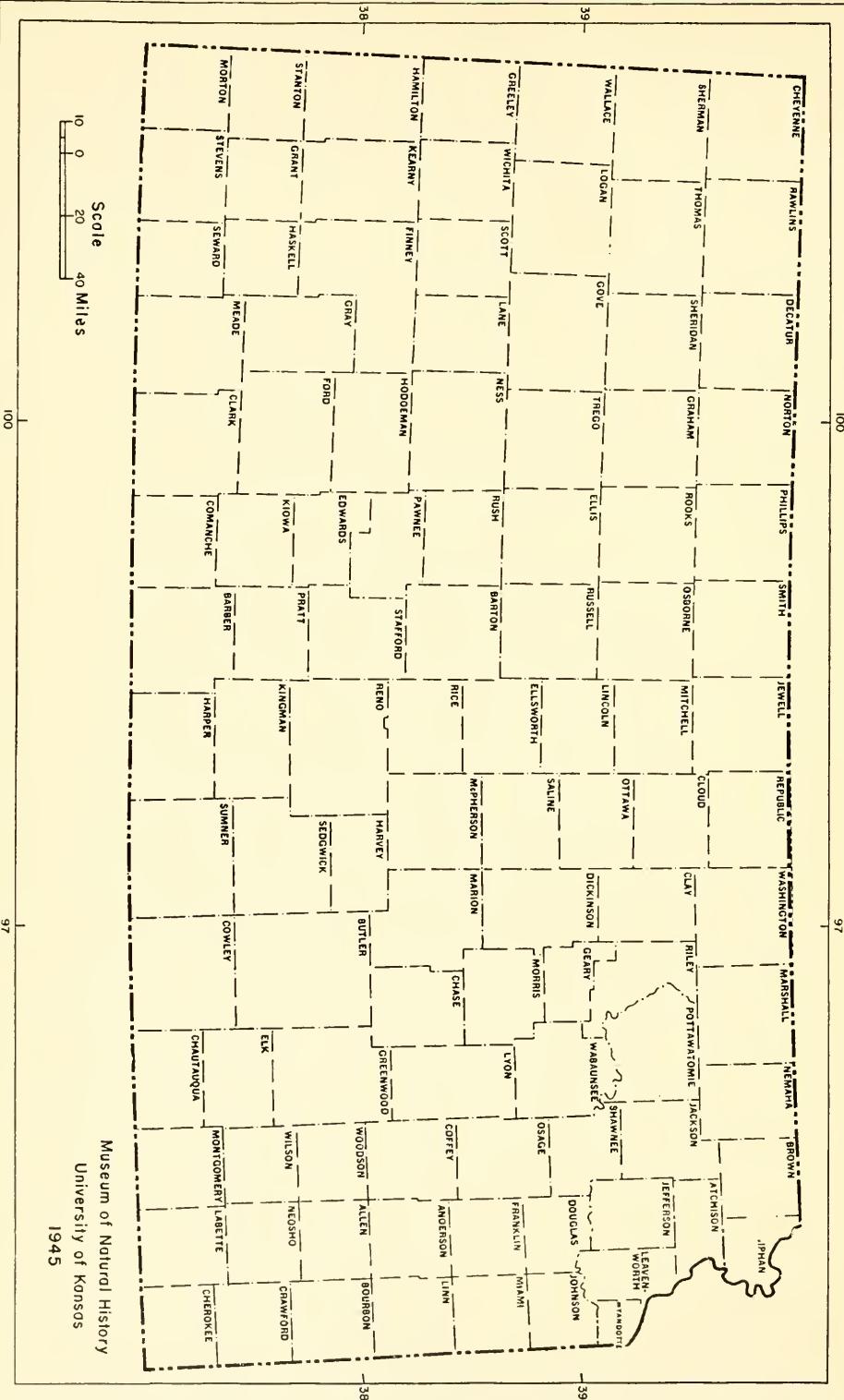


FIG. 100. Map of Kansas showing names of the counties

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